WMC Health | St. Anthony Community Hospital

Westchester Medical Center Health Network

BON SECOURS
ST. ANTHONY COMMUNITY HOSPITAL
RADIOLOGY SUITE
PHASE II

July 21, 2023
90% ISSUED FOR BID

HA PN: 2021-069

HIGHLAND ASSOCIATES

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SECTION 26 05 00 - COMMON WORK RESULTS - ELECTRICAL

PART 1 - GENERAL

1.1 EXECUTION OF THE WORK

A. These specifications call out certain duties of the Electrical Contractor and his Subcontractors. They are not intended as a material list of items required by the Contract. Any reference in these specifications and on the accompanying drawings to the Contractor, Electrical Contractor, Electrical Subcontractor or abbreviation "E.C.", shall be construed to mean the Contractor responsible for all electrical construction (Division 26) work for this project.

B. This division of the specifications covers the electrical systems of the project. It includes work performed by the electrical trades as well as trades not normally considered as electrical trades.

C. Provide all items and work indicated on the Drawings and all items and work called for in this division of the specifications in accordance with the conditions of Contract (Division 01 General Requirements Documents). This includes all incidentals, equipment, appliances services, hoisting, scaffolding, supports, tools supervision, labor consumable items, fees licenses, etc., necessary to provide complete systems. Perform start-up and checkout on each item and system to provide fully operable systems.

D. Comply with all provisions of the Contract Documents including the General Conditions, and Division 01 General Requirements of the specifications.

E. Certain terms such as "shall, provide, install, complete, start-up" are not used in some parts of these specifications. This does not indicate that the items shall be less than completely installed or that systems shall be less than complete.

F. Examine and compare the Electrical Drawings with these specifications, and report any discrepancies between them to the Architect/Engineer and obtain from him written instructions for changes necessary in the work. At time of bid the most stringent requirements must be included in said bid.

G. Examine and compare the Electrical Drawings and Specifications with the Drawings and Specifications of other trades, and report any discrepancies between them to the Architect/Engineer and obtain from him written instructions for changes necessary in the work. At time of bid, the most stringent requirements must be included in said bid.

H. Install and coordinate the electrical work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor, caused by his neglect to do so, shall be made by him at his own expense.

I. It is the intent of the Drawings and Specifications to provide a complete workable system ready for the Owner’s operation. Any item not specifically shown on the Drawings or called for in the Specifications, but normally required to conform with the intent, are to be considered a part of the Contract.

J. These specifications are basically equipment, installation, and performance Specifications. Some installation details are indicated on the Drawings. Where these differ from the Specifications, apply the more stringent at time of bid. Upon award of bid, contact Architect/Engineer for definite instructions.

K. All materials furnished by the Contractor shall be new and unused (temporary lighting and power products are excluded) and free from defects. All materials used shall bear the Underwriter's Laboratory, Inc. label provided a standard has been established for the material in question.

L. All products and materials shall be new, clean, free of defects and free of damage and corrosion.

M. The exclusion from, or limitation in, the symbolism used on the Drawings or the language used in the Specifications for electrical work shall not be interpreted as a reason for omitting the accessories necessary to complete any required system or item of equipment.

N. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.

O. Except for conduit, conduit fittings, outlet boxes, wire and cable, all items of equipment or material shall be the product of one manufacturer throughout. Multiple manufacturers will not be permitted.

P. Receive, inspect, store, install and wire Owner-furnished equipment where Owner furnished equipment is supplied.

Q. Painting

1. All manufactured electrical equipment such as switchgear, control equipment, lighting fixtures, etc., shall have factory-applied finish as specified in the appropriate article in the Electrical Parts of the Specification.

2. All other uncoated steel items such as boxes supports, hanger, rods, etc., shall be galvanized or have a shop coat of paint applied under this Part of the Specification. Normally shop coats shall be an approved primer containing at least 50 percent rust inhibitive pigment, applied before assembling the different parts.

3. Including painting and retouching of:

   a. Pre-finished enclosures of switchgear, panelboards, transformers, switches, wireways, bus ducts, etc., where the finish has been slightly damaged in transit before assembling the different parts.

   b. Any woodwork furnished in the electrical work.

   c. Fixture hangers, except those received from manufacturers that are prefinished.

   d. Miscellaneous iron brackets and supports.

   e. Steel conduits buried in earth.

4. Woodwork installed under this part of the specification shall be finished with filler sealer plus two (2) coats of PPG "Water Spar" gloss varnish.

1.2 COORDINATION OF THE WORK

A. Certain materials will be provided by other trades. Examine the Contract Documents to ascertain these requirements.

B. Carefully check space requirements with other trades and the physical confines of the area to ensure that all material can be installed in the spaces allotted thereto including finished suspended ceilings and the spaces within the existing building. Make modifications thereto as required and approved.

C. No items foreign to the electrical system shall be run in the dedicated space of the electrical equipment. Dedicated space shall be defined as the width and depth of the equipment from the floor to the bottom of the structural ceiling. Foreign systems include but are not limited to ductwork, piping, sprinklers, drip trays, etc. Contractor shall be responsible to coordinate the locations of the dedicated spaces with all trades as required.

D. Transmit to other trades all information required for work to be provided under their respective Sections in ample time for installation.

E. Wherever work interconnects with work of other trades, coordinate with other trades to ensure that all trades have the information necessary so that they may properly install all the necessary connections and equipment. Identify all items of work that require access so that the ceiling trade will know where to install access doors and panels.

F. Due to the type of installation, a fixed sequence of operation is required to properly install the complete systems. Coordinate, project and schedule work with other trades in accordance with the construction sequence.

G. The locations of lighting fixtures, outlets, panels and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.

H. Exercise particular caution with reference to the location of panels, outlets, switches, etc., and have precise and definite locations approved by the Architect/Engineer before proceeding with the installation.

I. The Drawings show only the general run of raceways and approximate location of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect/Engineer and receive his approval before such alterations are made. All such modifications shall be made without additional cost to the Owner.

J. Obtain from the Architect/Engineer in the field, the location of such outlets or equipment not definitively located on the Drawings.

K. Circuit "tags" in the form of arrows are used where shown to indicate the home runs of raceways to electrical distribution points. These tags show the circuits in each home run and the panel designation. Show the actual circuits numbers on the finished record tracing and on panel directory card. Where circuiting is not indicated, Electrical Contractor must provide required circuiting in accordance with the loading indicated on the drawings and/or as directed.

L. The Drawings generally do not indicate the exact number wires in each conduit for the branch circuit wiring of fixtures, and outlets, or the actual circuiting. Provide the correct wire size and quantity as required by the indicated circuiting and/or circuit numbers indicated and control, wiring diagrams, if any, specified voltage drop or maximum distance limitations, and the applicable requirements of the NEC.

M. Adjust location of conduits, panels, equipment, pull boxes, fixtures, etc. to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each raceway (and bus duct) prior to fabrication.

1. Right-of-Way:

a. Lines which pitch have the right-of-way over those which do not pitch. For example: steam, condensate, and plumbing drains normally have right-of way. Lines whose elevations cannot be changed to have right-of-way over lines whose elevations can be changed.

b. Make offsets, transitions and changes in direction in raceways (and bus duct) as required to maintain proper headroom in pitch of sloping lines whether or not indicated on the Drawings.

N. Wherever the work is of sufficient complexity, prepare additional Detail Drawings to scale similar to that of the bidding Drawings, prepared on tracing medium of the same size as Contract Drawings. With these layouts, coordinate the work with the work of other trades. Such detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit for review Drawings clearly showing the work and its relation to the work of other trades before commencing shop fabrication or erection in the field.

O. Contractor shall furnish services of an experienced Superintendent, who shall be in constant charge of all work, and who shall coordinate his work with the work of other trades. No work shall be installed before coordinating with other trades.

P. Coordinate with contractors for work under other Divisions of this specification for all work necessary to accomplish this contractor’s work.

Q. Where electrical connections are required, to equipment provided by the Owner or by other trades, this Contractor shall verify the exact requirements for these connections prior to ordering any materials or laying out any work. Where there is a discrepancy between the equipment being furnished and that shown on the Contract Drawings, the Contractor shall notify the Architect/Engineer for direction. Failure to comply with this coordination shall not constitute a reason for extra monies for equipment ordered or installed. Restocking charges will not be paid.

1.3 EXAMINATION OF SITE

A. Prior to the submitting of bids, the Contractor shall visit the site of the job and shall familiarize himself with all conditions affecting the proposed installation and shall make provisions as to the cost thereof. Failure to comply with the intent of this paragraph will in no way relieve the contractor of performing all necessary work shown on the Drawings.

1.4 PROGRESS OF WORK

A. The Contractor shall order the progress of his work so as to conform to the progress of the work of other trades and shall complete the entire installation as soon as the conditions of the building will permit. Any cost resulting from the defective or ill-timed work performed under this section shall be borne by the Contractor.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Ship and store all products and materials in a manner which will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain replacement or repair. Any such repairs shall be subject to review and acceptance of the Architect/Engineer.

B. Delivery of Materials: Deliver materials in manufacturer's unopened container fully identified with manufacturer’s name, trade name, type, class, grade, size and color.

C. Storage of Materials, Equipment and Fixtures: Store materials suitably sheltered from the elements, but readily accessibly for inspection by the Architect/Engineer until installed. Store all items, susceptible to moisture damage, in dry, heated spaces.

1.6 HOUSEKEEPING PADS AND ANCHOR BOLTS

A. Housekeeping pads for all floor mounted equipment shall be furnished by the General Contractor. Equipment pads shall conform to the shape of the piece of equipment it serves with a minimum 4" clear around the equipment and supports. Pads shall be a minimum of 4" high and made of a minimum 28 day, 2500 psi concrete reinforced with 6" x 6" 6/6 gauge welded wire mesh. Tops and sides of pad shall be troweled to smooth finishes, equal to those of the floors, with all internal corners bullnosed to 3/4" radius.

B. Furnish and install galvanized anchor bolts for all equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be the size and number recommended by the Manufacturer of the equipment and shall be located by means of suitable templates.

C. The Electrical Contractor shall furnish information on pad sizes to the General Contractor in a timely manner for him to proceed with his work. Failure to do so shall constitute a reason for the Electrical Contractor to provide such pads at his own expense.

1.7 EQUIPMENT ACCESSORIES

A. Provide supports, hangers and auxiliary structural members required for support of the work according to Section 26 05 29 "Hangers and Supports for Electrical Systems" and Section 26 05 48 "Vibration and Seismic Control for Electrical Components."

B. Furnish and set all sleeves for passage of raceways through structural, masonry and concrete walls or floors and elsewhere as will be required for the proper protection of each raceway (and bus duct) passing through building surfaces.

C. Wall mounted equipment may be directly secured to wall by means of steel bolts. Maintain at least 1" air space between equipment and supporting wall. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels providing a high degree of mounting flexibility, such as those manufactured by Kindorf, Glob-Strutt and Unistrut, may be used for mounting arrays of equipment.

1.8 EXCAVATION, TRENCHING AND BACKFILLING

A. Provide excavation for the Work. Excavate all material encountered, to the depths indicated on the drawings or required. Remove from the site, excavated materials not required or suitable for backfill as determined by the Soils Engineer. Provide grading, as may be necessary, to prevent surface water from flowing into trenches or other excavations. Remove any water accumulating therein. Provide sheeting and shoring as may be necessary for the protection of the Work and for the safety of personnel.

B. Provide trenches of widths necessary for the proper execution of the Work. Grade bottom of the trenches accurately to provide uniform bearing and support the Work on undisturbed soil at every point along its entire length. Except where rock is encountered, do no excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum overdepth of four (4") inches below the trench depths indicated on the Drawings or required. Backfill overdepths in the rock excavation and unauthorized overdepths with loose granular, moist earth, thoroughly machine tamped, to a compaction level of at least 92 maximum density as per ASTM D-1557 Modified Proctor Method. Whenever unstable soil that is incapable of properly supporting the Work, as determined by Soils Engineer, is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel, or other suitable material acceptable to the Soils Engineer.

C. Excavate trenches for utilities to a depth that will provide 24-inch minimum depths of cover from existing grade or from indicated finished grade, whichever is lower, unless otherwise specifically shown.

D. Trenches should not be placed within ten (10) feet of foundation or soil surfaces which must resist horizontal forces.

E. Do not backfill trenches until all required tests have been performed and the installation observed by the Soils Engineer. Comply with the requirements of other sections of these specifications. Backfill should consist of non-expansive soil with limited porosity. Deposit in eight (8") inch layers and thoroughly and carefully compact to 92% maximum density as per ASTM D-1557 Modified Proctor Method. Uniformly grade the finished surface.

F. The Contractor shall have and pay for the services of a qualified Soils Engineer approved by the Architect. Soils Engineer to submit test reports to the Architect.

1.9 CUTTING, PATCHING

A. The work shall be carefully laid out in advance. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of raceway, outlets or other equipment, the work shall be carefully done. Any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc. shall be repaired by skilled mechanics or the trades involved at no additional cost to the Owner.

B. The Contractor shall do no cutting, channeling, chasing or drilling of unfinished masonry, tile, etc., unless he first obtains permission from the Architect/Engineer. If permission is granted, the Contractor shall perform this work in a manner approved by the Architect/Engineer

C. Where conduits, mounting channels, outlet, junction, or pull boxes are mounted on a painted surface, or a surface to be painted, they shall be painted to match the surface. Whenever support channels are cut, the bare metal shall be cold galvanized.

D. Slots, chases, openings and recesses through floors, walls, ceilings, and roofs will be provided by the various trades in their respective materials. The trade requiring them to properly locate such openings and be responsible for any cutting and patching caused by the neglect to do so.

E. Structural steel fabricator and installer shall be responsible for the coordination of all framed openings in roof with approved equipment manufacturers. (Openings such as, but not limited to mechanical units, exhaust fans, curb mounted equipment, roof drains, skylights, stair openings, roof hatches, smoke hatches, duct thru roof penetrations, expansion joints, etc.)

Exact sizes and exact locations of all openings are to be verified with the approved shop drawings issued for the installation. The exact sizes shall be coordinated prior to any fabrication and installation by any/all trades. (Sizes and locations indicated on contract drawings are diagrammatic and for information only.)

Any fabrication and/or installation which has not been properly coordinated with approved equipment manufacturer and must be repaired, relocated, altered, replaced, re-installed or modified in any manner will be done to the satisfaction of the Owner with no additional cost to the Owner or design professional.

1.10 PROTECTING TRENCHES

A. Provide suitable barriers and warning tapes around all trenches to prevent accidental stepping or driving into them. Where left open overnight, provide warning lights in addition to tape barriers.

B. Remove water from trenches on a daily basis, weather permitting.

1.11 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire resistance of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping".

1.12 NORMAL VOLTAGES (Unless Otherwise Noted)

A. Primary Distribution – above 480 volts.

B. Secondary Distribution – 277/480 Volt, 3 phase, 4 wire and 120/208 volt, 3 phase 4 wire.

1.13 MOUNTING HEIGHTS

A. Unless otherwise noted or required because of special conditions, locate outlets as follows:

1. Heights listed are from finished floor to center of device. Verify exact locations with the Architect/Engineer before installation.

a. Convenience and Signal Outlets, Telephone and Data: 18 inches, unless otherwise noted.

b. Lighting Switches: 3 feet, 6 inches (42 inches).

c. Disconnect Switches and Motor Controller: Five (5) feet.

d. Wall Phone Outlets: Forty Eight (48) inches; Forty Two (42) inches to top for ADA compliant.

e. Exit Lights: Two (2) inches above top of door to bottom.

f. Audio/Visual Fire Alarm Devices: Eighty (80) inches to bottom.

g. Fire Alarm Pull Stations: Forty Two (42) inches.

h. Wall-mounted Fixtures – 7'- 6" or over mirrors (as applicable) or one (1) foot below ceilings lower than eight (8) feet. Stairwell fixtures to be mounted 8 feet 6 inches above finished floor or one (1) foot below ceiling.

B. Unless otherwise noted or required because of special conditions the mounting heights of all equipment shall match that in the existing building, if those mounting heights comply with A.D.A.

1.14 DEMOLITION AND CONTINUANCE OF EXISTING SERVICES – REFER TO SECTION 26 07 00

A. All existing electrical services not specifically indicated to be removed or altered shall remain as they presently exist.

B. Should any existing services, etc., interfere with new construction, the Contractor shall (after obtaining written approval from the Architect/Engineer) alter or reroute such existing equipment to facilitate new construction.

C. Under no circumstances shall existing services, etc., be terminated or altered unless deemed necessary by the Architect/Engineer or specified herein; also, prior to altering any existing situation, the Contractor shall notify the Owner in writing giving two (2) weeks advance notice of planned alteration.

D. It shall be solely the Contractor's responsibility to guarantee continuity of present facilities (with respect to damage or alteration due to new construction) and any unauthorized alteration to existing equipment shall be corrected by the Contractor to the Architect/Engineer's satisfaction at the Contractor's expense.

1.15 CLEANING UP

A. Contractor shall take care to avoid accumulation of debris, boxes, crates, etc., resulting from the installation of his work. Contractor shall remove from the premises each day all debris, boxes, etc., and keep the premises clean, subject to the Architect/Engineer’s instructions, which shall be promptly carried out.

B. Contractor shall clean all fixtures and equipment at the completion of the project.

C. All switchboards, panelboards, wireways, trench ducts, cabinets, enclosures, etc. shall be thoroughly vacuumed clean prior to energizing equipment and at the completion of the project. Equipment shall be opened for observation by the Architect/Engineer as required.

1.16 WATERPROOFING

A. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, perform it prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect/Engineer and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.

B. If Contractor penetrates any walls or surfaces after they have been waterproofed, he shall restore the waterproof integrity of that surface as directed by the Architect/Engineer at his own expense, using workmen skilled in that trade.

1.17 SUPPORTS AND FASTENERS

A. Provide supports, hangers and auxiliary structural members required for support of the work according to Section 26 05 29 "Hangers and Supports for Electrical Systems" and Section 26 05 48 "Vibration and Seismic Control for Electrical Components."

B. Furnish and set all sleeves for passage of raceways through structural, masonry and concrete walls or floors and elsewhere as will be required for the proper protection of each raceway (and bus duct) passing through building surfaces.

C. Wall mounted equipment may be directly secured to wall by means of steel bolts. Maintain at least 1" air space between equipment and supporting wall. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels providing a high degree of mounting flexibility, such as those manufactured by Kindorf, Glob-Strutt and Unistrut, may be used for mounting arrays of equipment.

1.18 PROHIBITED LABELS AND IDENTIFICATIONS

A. Prohibited Markings: In all public areas, tenant areas and similar locations within the project, the inclusion or installation of any item, element or assembly which bears on any exposed surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited. Also prohibited is the inclusion or installation of any article which bears visible evidence that an insignia, name, label, or other device had been removed.

B. Exception: Required Underwriter's Laboratory labels shall not be removed nor shall identification specifically required under the various technical sections of the specifications be removed.

1.19 COORDINATION WITH UTILITY COMPANIES

A. The Electrical Contractor shall be responsible for contacting and meeting with the respective utility companies to obtain electric, telephone and/or television services. He shall make all arrangements for these services and pay all costs associated with the installation including utility company charges.

B. The Electrical Contractor shall provide all conduit, wiring, excavation and backfill necessary to bring electric, telephone and/or television services into the building.

C. Do not order any materials associated with these services without prior approval from the respective utilities. With respect to this, special attention is called to fuses and circuit breakers which must be coordinated with the Power Company.

1.20 CONNECTION TO EXISTING UTILITIES AND SYSTEMS

A. If connecting to an existing system, the Electrical Contractor shall be responsible to verify the integrity of the system being connected to. All applicable testing and acceptance will apply.

PART 2 - PRODUCTS

2.1 MATERIALS

A. If products and materials are specified or indicated on the Drawings for a specific item or system, use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, subject to approval of Shop Drawings where Shop Drawings are required or as approved in writing where Shop Drawings are not required.

B. All equipment capacities, etc. are listed for job site operating conditions. All equipment sensitive to altitudes or ambient temperatures shall be derated and method of derating shown on Shop Drawings. Where operating conditions shown differ from the laboratory test conditions, the equipment shall be derated and the method of derating shown on Shop Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer's instructions for installing, connecting, and adjusting all equipment. Provide one copy of such instructions to the Architect/Engineer before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Provide all special supports, connections, wiring, accessories, etc.

B. Use mechanics skilled in their trade for all work.

C. Keep all items protected before and after installation. Clean up all debris.

D. Perform all tests required by local authorities in addition to tests specified herein, such as life safety systems.

E. Applicable equipment and materials to be listed by Underwriters' Laboratories and Manufactured in accordance with ASME, NEMA, ANSI or IEEE standards, and as approved by local authorities having jurisdiction as mentioned in Division 1.

F. Before commencing Work, examine all adjoining, underlying. Work on which this Work is in any way dependent for perfect workmanship and report any condition which prevents performance of first class work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

3.2 PREMIUM TIME WORK

A. The following Work shall be performed at night or weekend other than holiday weekends as directed and coordinated with the Owner.

1. All tie-in, cut-over and modifications to the existing electrical system and other existing system requiring tie-ins or modifications shall be arranged and scheduled with the Owner to be done at a time as to maintain continuity of the service and not interfere with normal building operations.

3.3 PROJECT MANAGEMENT AND COORDINATION

A. Coordination: Coordinate construction operations included in different Sections of the Specification to ensure efficient and orderly installation of each part of the work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the work depends on installation of other components, before or after its own installation.

2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.

3. Make adequate provisions to accommodate items scheduled for later installation.

4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule
2. Preparation of the Schedule of Values
3. Installation and removal of temporary facilities and controls
4. Delivery and processing of submittals
5. Progress meetings
6. Pre-installation conferences
7. Project closeout activities
8. Startup and adjustment of systems
9. Project closeout activities

D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into the work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

3.4 SUBMITTALS

A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.

1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:

    a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.

    b. Indicate required installation sequence.

    c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

2. Number of Copies: Submit three opaque copies of each submittal. Architect, through Construction Manager, will return one copy.

    a. Submit five copies where Coordination Drawings are required for operation and maintenance manuals. Architect and Construction Manager will retain two copies; remainder will be returned. Markup and retain one returned copy as a Project Record Drawing.

3. Refer to individual Sections for Coordination Drawing requirements for work in those Sections.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project Site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

3.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

A. General: In addition to Project Superintendent, provide other administrative and supervisory personnel as required for proper performance of the work.

3.6 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project Site, unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.

2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.

3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner, Construction Manager, and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the work.

2. Agenda: Discuss items of significance that could affect progress, including the following:

a. Tentative construction schedule
b. Phasing
c. Critical work sequencing and long-lead items
d. Procedures for processing field decisions and Change Orders
e. Procedures for requests for interpretations (RFIs)
f. Procedures for testing and inspecting
g. Procedures for processing Applications for Payment
h. Submittal procedures
i. Preparation of Record Documents
j. Use of the premises and existing building
k. Work restrictions
l. Owner's occupancy requirements
m. Responsibility for temporary facilities and controls
n. Construction waste management and recycling
o. Parking availability
p. Office, work, and storage areas
q. Equipment deliveries and priorities
r. First aid
s. Security
t. Progress cleaning
u. Working hours

3. Minutes: Record and distribute meeting minutes.

C. Pre-installation Conferences: Conduct a pre-installation conference at Project Site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Construction Manager of scheduled meeting dates.

2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

    a. The Contract Documents
    b. Deliveries
    c. Review of mockups
    d. Possible conflicts
    e. Time schedules
    f. Manufacturer's written recommendations
    g. Acceptability of substrates
    h. Temporary facilities and controls
    i. Coordination with other work
    j. Protection of construction and personnel

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Conduct progress meetings at biweekly intervals. Coordinate dates of meetings with preparation of payment requests.

1. Attendees: In addition to representatives of Owner, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the work.

2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

        1) Review schedule for next period.

    b. Review present and future needs of each entity present, including the following:

        1) Interface requirements
        2) Status of submittals
        3) Off-site fabrication

4) Site utilization
5) Hazards and risks
6) Progress cleaning
7) Status of correction of deficient items
8) Requests for interpretations (RFIs)
9) Status of proposal requests
10) Pending changes
11) Status of Change Orders
12) Pending claims and disputes
13) Documentation of information for payment requests

3. Minutes: Record the meeting minutes.

4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.

   a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

END OF SECTION 26 05 00

SECTION 26 05 01 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Provide the Work included in accordance with the Contract Documents.

B. Provide all labor, materials, equipment, tools, appliances, auxiliaries, services, hoisting, scaffolding, support, supervision, and Project Record Documents, and perform all operations for the furnishing and installing of the complete electrical system, including but not limited to the work described hereinafter. The work shall meet or exceed the latest codes, regulations and requirements required by the local Building Department (as mentioned in Division 01).

C. The electrical work is shown schematically on the Drawings to indicate the general system arrangement and configuration. The work of this Division shall include coordination with the work of other Divisions of the Specifications and the Contract Documents so as to provide a complete and operational system capable of being readily operated and maintained, including approved re-arrangement of the systems and equipment and re-routing of distribution services to enable the complete system to fit within the confines of the allotted electrical spaces, all to the satisfaction of the Architect/Engineer or as directed by the Architect/Engineer.

D. The work shall include but not limited to the following:

1. Panelboards/Switchgear
2. Feeder and branch circuits
3. Wiring devices
4. Lighting fixtures
5. Lighting controls
6. Equipment connections
7. Voice/Data conduit
8. Television conduit
9. Security conduit
10. Fire alarm system

1.2 SETTING OUT OF WORK

A. Layouts shown for mechanical equipment and elevator machine rooms are for estimating purposes only. Coordinate installation of conduit, outlets, luminaries, and equipment with final room equipment layout as supplied by equipment supplier.

B. Where switches, receptacles, fire alarm pull stations, are in the same general location, outlets shall be aligned vertically unless otherwise called for by the Architect. Comply with ADA mounting heights.

C. All equipment capacities, etc. are listed for job site operating conditions. All equipment sensitive to altitudes or ambient temperatures shall be derated and method of derating shown on the Shop Drawings.

D. Use mechanics skilled in their trade for all work.

E. Keep all items protected before and after installation. Clean up all debris.

F. Perform all tests required by local authorities in addition to tests specified herein, such as life safety systems.

G. Applicable equipment and materials shall be listed by Underwriters' Laboratories and manufactured in accordance with ASME, NEMA, ANSI or IEEE standards and as approved by local authorities having jurisdiction.

H. Before commencing work, examine all adjoining, underlying, etc., work on which this work is in any way dependent for perfect workmanship and report any condition which prevents performance of first class work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

1.3 MECHANICAL EQUIPMENT WIRING

A. Provide all labor and materials required to complete electrical (power) wiring for plumbing, heating and ventilating, elevators, escalators and miscellaneous equipment, as called for in these specifications and/or shown on the Drawings.

B. Provide all single phase motor protection switches and combination starters mounted within motor control centers, and disconnects as required for mechanical equipment unless otherwise specifically noted in these specifications or on the drawings. Remote starters will be provided by the trade providing the motor.

C. Confirm final connections, loads, and locations of motors prior to ordering of equipment and installation.

END OF SECTION 26 05 01

SECTION 26 05 02 - ELECTRICAL ABBREVIATIONS AND DEFINITIONS

PART 1 - GENERAL

1.1 REFERENCES

A. Utilize the following abbreviations and definitions for discernment within the Drawings and Specifications.

1. Abbreviations

a.	NEC	National Electrical Code
b.	OSHA	Occupational Safety and Health Act
c.	ANSI	American National Standards Institute
d.	NFPA	National Fire Protection Association
e.	ASA	American Standards Association
f.	IEEE	Institute of Electrical and Electronics Engineers
g.	NEMA	National Electrical Manufacturers Association
h.	UL	Underwriters' Laboratories, Inc.
i.	IES	Illuminating Engineering Society
j.	IPCEA	International Power Cable Engineers Association
k.	ASTM	American Society of Testing Materials
l.	ETL	Electrical Testing Laboratories, Inc.
m.	CBM	Certified Ballast Manufacturers
n.	EIA	Electronic Industries Association
o.	BIL	Basic Impulse Level
p.	LED	Light Emitting Diode
q.	O.E.M.	Original Equipment Manufacturer
r.	IBC	International Building Code

1.2 DEFINITIONS

A. "PROVIDE" means to supply, purchase, transport, place, erect, connect, test, and turn over to Owner, complete and ready for regular operation, the particular Work referred to.

B. "INSTALL" means to join, unite, fasten, link, attach, set up, or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation, the particular work referred to.

C. "FURNISH" means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories, and all other items customarily required for the proper and complete application for the particular Work referred to.

D. "WIRING" means the inclusion of all raceways, fittings, conductors, connectors, tape, junction and outlet boxes, connections, splices, and all other items necessary and/or required in connection with such Work.

E. "CONDUIT" means the inclusion of all fittings, hangers, supports, sleeves, etc.

F. "AS DIRECTED" means as directed by the Architect/Engineer, or his representative.

G. "CONCEALED" means embedded in masonry or other construction, installed behind wall furring or within double partitions, or installed within hung ceilings.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

A. NOT USED

END OF SECTION 26 05 02

SECTION 26 05 03 - CODES, FEES

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Comply with Codes in accordance with the Contract Documents.

1.2 CODES

A. The electrical installation shall comply with the National Electrical Code and any other agency or authority having jurisdiction in this area.

B. All equipment shall be equal to or exceed the minimum requirements of N.E.M.A., I.E.E.E., and UL.

C. Should any change in Drawings or Specifications be required to comply with governmental regulations, the Contractor shall notify Architect/Engineer prior to execution of the Work. The work shall be carried out according to the requirements of such code in accordance with the instruction of the Architect/Engineer and at no additional cost to the Owner.

D. The provisions of Standards, Codes, Laws, Ordinances, etc., shall be considered minimum requirements. In case of conflict between their published requirements, the Owner's Representative shall determine which is to be followed and his decision shall be binding. Specific requirements of this specification and/or the drawings which exceed the published requirements shall take precedence over them.

1.3 FEES

A. All local fees and permits and services of inspection authorities shall be obtained and paid for by the Contractor. The Contractor shall cooperate fully with local companies with respect to their services. Contractor shall include in his bid; any costs to be incurred relative to power service (primary and/or secondary) and telephone service.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION 26 05 03

SECTION 26 05 04 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work under this section is subject to requirements of the contract documents, including the general conditions and supplementary conditions, and sections under Division 01, General Requirements.

B. During construction, keep an accurate record of all deviations between the work as shown on Drawings and that which is actually installed. Keep this record set of prints at job site for review by the Architect/Engineer.

C. Upon completion of the installation and acceptance by the Owner, obtain from the Architect a complete set of black and white prints of the original contract drawings. Supplemental drawings, clarification drawings, change order drawings, etc., will not be furnished. Enter thereon, in a neat and accurate manner, a complete record of all revisions to the original Drawings as actually installed. This shall include but not be limited to all information relative to change orders, field directive, clarifications (either in written form or drawings), field modifications, etc. Submit this set of black and white prints to the Architect/Engineer for review. After review by the Architect/Engineer, make necessary changes and then deliver them to the Architect for transmittal to the Owner.

D. Provide in each main electrical service room a framed copy, under glass, of the appropriate One Line Riser Diagram as reviewed by the electrical engineer. Media shall be a high quality presentation type paper.

E. Provide location of all underground conduits outside and all feeders (1000 amps or more) on the interior. Show dimensioned location from a wall or column line and the depth.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION 26 05 04

SECTION 26 05 05 - REVIEW AND ACCEPTANCES

PART 1 - GENERAL

1.1 SUBSTITUTION OF MATERIALS OR EQUIPMENT

A. Wherever the words "for approval" or "approved" are used in regard to manufactured specialties, or wherever it is desired to substitute a different make or type of apparatus for that specified, submit all information pertinent to the adequacy and adaptability of the proposed apparatus, and secure Architect/Engineer's acceptance before apparatus is ordered.

B. All requests for substitution of materials or equipment shall be made by the Contractor within thirty (30) days after the execution of the Owner/Contractor Agreement. No requests for substitution will be accepted prior to execution of the Owner/Contractor Agreement or from anyone other than the successful Contractor.

C. Wherever quantities or a definite make and size of apparatus is specified, the make and size of apparatus which is proposed must conform substantially (in regard to the operating results) to that specified or implied. Same shall apply to important dimensions relating to operation of apparatus in coordination with the rest of the system, or to properly fitting it into available space conditions. Any substitution of equipment or apparatus shall include all necessary revisions, as required to complete the installation.

D. Acceptance of substitutions, for equipment specified herein, will not be given merely upon submission of manufacturer's names and will be given only after receipt of complete and satisfactory performance data covering the complete range of operating conditions in tabular and graphical form. Furnish complete and satisfactory information relative to equipment dimensions, weight, etc. Acceptance of all equipment specified or shown on the Drawings, or substitutions submitted for that specified or shown on the Drawings, will be granted if such equipment, in the opinion of the Architect/Engineer, conforms to the performance requirements, space conditions, weight requirements and quality requirements. Any additional construction and design costs incurred, as a result of any accepted substitution, shall be borne by this Contractor. The opinion and judgement of the Architect/Engineer shall be final, conclusive, and binding.

1.2 SUBMITTAL LIST

A. Product Data, Shop Drawings: Bear stamp of approval of authority having jurisdiction and the Owner's insurance underwriter.

B. Within thirty (30) days after date of execution of the Owner/Contractor Agreement, submit for review and acceptance, a list of all material and equipment manufacturers whose products are proposed, as well as names of all subcontractors whom this trade proposes to employ

C. Any requests for substitutions of equipment or materials must be submitted and returned prior to submitting the Submittal List. Only specified or accepted manufacturers or suppliers shall appear on the Submittal List.

D. The complete Submittal List must be reviewed and accepted by the Architect/Engineer prior to submittal of Shop Drawings. No Shop Drawings will be processed without an accepted Submittal List.

E. The Submittal List shall include all material, systems, and equipment as listed herein.

1.3 SHOP DRAWINGS

A. Within 90 days after date of execution of the Owner/Contractor Agreement, prepare and submit detailed Shop Drawings for materials, systems and equipment as listed herein, in each section of this specification. Should the Contractor fail to submit shop drawings in a timely manner, or fail to order materials in a timely manner, the Contractor shall be required to install temporary materials when deemed necessary to avoid delaying the project. The Contractor shall replace the temporary materials with the specified materials at his/her own cost.

B. The Work described in any Shop Drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job. Each submitted Shop Drawing shall include a certification that all related job conditions have been checked and that no conflict exists.

C. All drawings shall be submitted sufficiently in advance of field requirements to allow ample time for checking and re-submittal as may be required. All submittals shall be complete and contain all required and detailed information. Re-submittals shall be made within fourteen (14) days of receipt of rejected submittals.

D. Acceptance of any submitted data or Shop Drawings for material, equipment apparatus, devices, arrangements, and layout shall not relieve Contractor from responsibility of furnishing same of proper dimensions and weight, capacities, sizes, quantity, quality and installation details, to efficiently perform the requirements and intent of the Contract. Such acceptance shall not relieve Contractor from responsibility for errors, omissions, or inadequacies of any sort on submitted data or Shop Drawings.

E. Each Shop Drawing shall contain job title and reference to the applicable drawing and specification article.

F. Individual Shop Drawing submittals shall be provided for each specific material, system or equipment as identified herein. Submittals provided in other than this manner will be returned without review.

G. All nameplate data shall be complete at time of equipment submittals – refer to Section 26 05 53 for identification requirements.

H. For each room or area of the building containing switchboards, panelboards, motor control centers, transformers, emergency generators, substations, dimming cabinets, sound system cabinets, bus ducts, telephone backboards, signal system backboards, fire alarm terminal cabinets, fire alarm control panels, consoles, etc., the following is required to be submitted for review and acceptance at the time of the equipment submittal.

1. Floor Plans

a. Plan views (including sections and elevations when requested) for the equipment indicated in the exact location in which it is intended to be installed. These plans shall be of a scale not less than 1/4" = 1'-0". They shall be prepared in the following manner.

1) Indicate the physical boundaries of the space in including door/swings, ceiling heights, and ceiling types (as applicable).

2) Illustrate all electrical equipment proposed to be contained herein. Include top and bottom elevations of all electrical equipment. The Drawings must be prepared utilizing the dimensions contained in the individual equipment submittal.

3) Illustrate all other equipment therein such as conduits, detectors, luminaries, ducts, registers, pullboxes, wireways, and structural elements.

4) Note the operating weight of each piece of equipment.

5) Note the heat release from each piece of electrical equipment in terms of BTU per hour. This information shall be supplied by the respective manufacturers.

6) Illustrate all concrete pads, curbs, etc.

7) Note all code clearances from all equipment by dimensions.

8) Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation).

9) On engine generator layout plans, indicate position of radiator and direction of air movement and provide manufacturer's signed statement that engine will operate within approved temperature ranges as shown on the plans.

2. Equipment Removal Routes

a. Provide in conjunction with the above, a set of documents reproduced from the then current Contract Documents, indicating the methods of equipment removal for all major pieces of equipment.

b. Indicate on floor plans, by means of arrows, the complete path for equipment removal.

c. Where equipment will be required to be hung temporarily from a slab or beam, note same on the submission, including the weight of the equipment to be hung and the weight of the hoisting equipment.

d. Note all heights of conduits, ductwork, beams, doorways, transoms, piping, etc., in the proposed path assuring that adequate headroom is provided.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

ELECTRICAL SUBMITTAL LIST

DATA:
CONTRACTOR:

EQUIPMENT	MANUFACTURER	REMARKS
Raceways		
Wire and Cable (480 Volts and Below)		
Switches Receptacles		
Wall Plates		
Grounding System		
Disconnecting Switches		
Fuses		
Panelboards		
Dry Type Transformers (480 volts and below)		
Contactors		
Luminaires (each type specified)		
Lamps		
Exit Lights		
Poles & Standards		
Battery Operated Emergency Lights		

NOTE: THIS IS A SAMPLE LIST AND DOES NOT NECESSARILY REFLECT THE EQUIPMENT LIST REQUIRED FOR THIS PROJECT.

END OF SECTION 26 05 05

SECTION 26 05 06 - GUARANTEE

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide a Guarantee in accordance with the Contract Documents

B. Submit a single guarantee stating that all portions of the work are in accordance with Contract requirements. Guarantee all work against faulty and improper material and workmanship for a period of one (1) year from date of final acceptance by the Owner; except that where guarantees or warranties for longer terms are specified herein, such longer term shall apply. Within 24 hours after notification, correct any deficiencies which occur during the guarantee period at no additional cost to the Owner, all to the satisfaction of the Owner and Owner/Engineer. Obtain similar guarantees from subcontractors, manufacturers, suppliers and subtrade specialists.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION 26 05 06

SECTION 26 05 07 - MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide maintenance manuals in accordance with Contract Documents.

1.2 SUBMITTALS

A. Provide five (5) copies of each manual.

B. Manuals to be 8-1/2 inches x 11 inches in hard back 3-ring loose leaf binders. Use more than one volume if required; do not overfill binders.

C. Submit one (1) copy to Architect/Engineer. After review and acceptance assemble other copies.

D. Manuals to be completed and in Owner's hands prior to turning building over to Owner and at least 10 days prior to instruction to operating personnel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS LITERATURE

A. General: Provide manufacturers literature on all items of equipment and components as regularly published by the respective manufacturers for proper preventative and comprehensive maintenance.

PART 3 - EXECUTION

3.1 Provide maintenance manuals including but not limited to the following:

A. Alphabetical list of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.

B. Operating instructions for complete system including:

1. Normal starting, operating, and shut-down.
2. Emergency procedures for fire or failure of major equipment.
3. Summer and winter special procedures, if any.
4. Day and night special procedures, if any.

C. Maintenance instruction including:

1. Proper lubricants and lubricating instructions for each piece of equipment, and date when lubricated.

2. This shall be a separate list in addition to manufacturer's data.

3. Necessary cleaning, replacement and/or adjustment schedule.

D. Manufacturer's Data and Each Piece of Equipment including:

1. Installation instructions.

2. Drawings and specifications.

3. Parts list, including recommended items to be stocked.

4. Complete wiring diagrams.

5. Marked or changed prints locating all concealed parts and all variations from the original system design.

6. Test and inspection certificates.

3.2 Provide specific equipment data including, but not limited to, materials and equipment listed in Section 26 05 14.

END OF SECTION 26 05 07

SECTION 26 05 09 - TEMPORARY LIGHTING AND POWER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide temporary lighting and power as required.

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Local Electric Utility Standards
2. Federal Public Law PL-91-596 cited as the Williams-Steiger Occupational Safety and Health Act of 1970.

PART 2 - PRODUCTS

2.1 The Contractor shall make all necessary arrangements with the Owner for the new installation of temporary lighting and power services tailored for this project and the setting of temporary meters in accordance with the Utility Company's requirements. He shall pay for the installation and maintenance of all temporary light and power wiring, including, but not limited to conduits, wire, switches, fuse boxes, receptacles, distribution panel boards, fused disconnect switches, ground fault interruption equipment, fixtures, lamps, fuses and any other incidental material and/or equipment required to provide sufficient illumination and power, as required by the state Labor Board, O.S.H.A., or all other authorities having jurisdiction for all areas of the site where work will be performed by this Contractor, his subcontractors, or any other contractors. Size and voltage requirements to be coordinated with the General Contractor.

2.2 Furnish and install lighting as necessary including those required for trailers and/or temporary offices. He shall also furnish and install one complete set of fuses for temporary light and power services, as required. Provide replacement fixtures and fuses as required during construction.

2.3 Rubber covered trailers, each 40' long, having plugs, sockets and locked type guards, shall be supplied by this contractor for use by other contractors, as required.

2.4 Temporary power circuits and outlets, etc. shall be provided in accordance with the power requirements of the various horsepower ratings of the equipment to be installed under all contracts and for temporary motors, elevator, etc. Temporary power required for motor operated tools and appliances to be used by various contractors in construction work, and not be a part of the permanent equipment shall be provided.

PART 3 - EXECUTION

3.1 Irrespective of the union working hours for the electricians, the Electrical Contractor shall maintain and pay the entire regular and overtime labor costs of keeping the temporary light and power system energized from a period 15 minutes before the established starting time of the building trade which starts work earliest to a period of 15 minutes after the established stopping time of the trade which stops work last. This shall apply to every working day of the week during the life of the contract, unless otherwise directed, or until such time that the maintenance of the temporary light and power system is no longer required by reason of the activation of and use of the permanent light and power systems.

3.2 When the electricians are entitled to a holiday or holidays under union rules and other building trade workmen are required to work and do not have the same holiday or holidays, the Electrical Contractor shall maintain and pay the entire overtime labor costs of keeping the temporary light and power system energized for the full day or those full days, as the case may be, including the extra 15 minutes before the start and after the close of the working day, as stated in the preceding paragraph.

3.3 Should this Contractor or any contractor require temporary light or power, or both, before or after the hours set forth in the preceding paragraphs, this Contractor or other contractors shall pay the extra cost of keeping the systems energized and in serviceable condition.

3.4 Remove the temporary light and power systems, when directed. This Contractor shall replace and make good all damage to the permanent systems, as required, replacing all damaged parts. Under no circumstances shall temporary wiring be left in finished hung ceiling spaces.

A. When the permanent lighting and power systems are installed and operational, this Contractor shall make the change-over. The cost of making the change-over of the electric services from the temporary lines to service from permanent lines shall be borne by this Contractor.

END OF SECTION 26 05 09

SECTION 26 05 10 - TESTING, INSPECTION AND CERTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. General – The Contractor shall completely test and inspect all systems in accordance with the specifications and drawings. The Contractor shall certify that all systems are in complete working order prior to turning over to the owner.

1.2 STANDARDS

A. Except as modified by governing codes and by the contract documents, comply with the latest applicable provisions and latest recommendations of the following:

1. NFPA
2. NEMA
3. NEC
4. IEEE
5. IPCEA
6. ANSI
7. UL
8. Local Fire Department

1.3 GENERAL TESTING

A. It shall be the responsibility of this Contractor to furnish all testing equipment and labor necessary to perform the following tests:

1. After wires or cables are in place, but before being connected to devices and equipment, the system shall be tested for shorts, opens, intentional and unintentional grounds. Wires or cables that are shorted or unintentionally grounded shall be replaced.

2. A voltage test shall be made on the last outlet of each branch circuit and the potential drop shall not exceed 2%. Voltage drops for panel and large feeders shall not exceed 3% hence the total voltage drop for a feeder and any branch circuit shall not exceed 5% of the service voltage. The test shall be made under design load or its equal.

3. Any wiring device or electrical apparatus in this contract, if grounded or shorted on an integral "line" part, shall be removed and the trouble corrected.

4. When required, complete test and inspection records shall be made and incorporated into a report for each piece of equipment tested. All readings taken shall be recorded. Four (4) copies shall be submitted to the Engineer for approval.

5. All tests must be conducted in the presence of Project Coordinator.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT AND MATERIALS

A. The Contractor shall provide all testing instruments, equipment and all materials, connections, etc., required to perform tests in accordance with these specifications.

PART 3 - EXECUTION

3.1 WIRING TEST

A. All wiring and cable tests shall be made before any circuits, main switch, motor, transformer or line is energized.

B. Tests shall be made for continuity, identification and absence of shorts and grounds for each conductor. Both ends of a given conductor shall be identified alike. Before circuit terminal connections are made, continuity and identification of wiring shall be checked by means of a DC test device using a bell, light, meter, or buzzer.

C. Insulation test shall be made at the following values:

480Y/277 Volt wiring at 1000 Volts DC
208Y/120 Volt wiring at 500 Volts DC

D. Insulation resistance between phase conductors and ground shall not be less than the minimum requirements of 2000 meg-ohms.

1. Wire terminations are not to be made to equipment (motors, MCCs, bus ducts, etc.), until that piece of equipment has been tested and verified as specified in this section.

2. Test motor feeders with motors disconnected, but with circuit breakers, switches or starters in the circuit opened so as to include only that portion of the feeder it is desired to test.

3. Test lighting feeders with the circuit breakers and panelboards connected but with lighting branch circuit breakers or switches open so as to include only the feeder circuit desired to test.

E. Contractor shall correct or replace any circuit which is defective or grounded and he shall also correct all other troubles encountered by these tests. All defects whether due to faulty workmanship or material furnished by the Contractor shall be corrected under this section at the Contractor's expense in a manner acceptable to the Engineer.

3.2 LIGHTING TEST

A. Check all lighting fixtures for proper operation. All Contractor supplied fixtures shall be 100% operable at no additional cost to the Owner. Repair cost to the Owner supplied fixtures shall not be the responsibility of the Contractor unless otherwise stated.

3.3 MOTOR TEST

A. All 460 volt motors shall be individually "spot tested" for insulation resistance using 1000V DC. All 208/120V motors shall be "spot tested" with 500V DC in a similar manner. The minimum resistance to ground shall be 2000 meg-ohm (corrected to 20 degrees C). The Contractor shall record the ambient temperature of the motor and submit this value along with insulation resistance value.

B. Make the following checks on all motors prior to start-up:

1. Check motor name plates for H.P., speed, phase and voltage. Verify proper wiring.
2. Check shaft for freedom of rotation.
3. Verify that the motor is properly lubricated prior to energizing.

C. Contractor shall furnish a proper sized heater for each overload relay. Notify the Engineer prior to installation of the motor full-load current rating, the number of overload relays, the starter catalog number, and the heater catalog number. The Engineer will aid in the selection of the proper heaters if requested, provided all pertinent information is given.

D. Make the following tests on all motors during or immediately after start-up:

1. Check for proper shaft rotation.
2. Check motor for smooth operation (vibration).
3. Take a current reading using a clamp-on ammeter. (No-load readings and loaded readings).

E. Equipment shall be put into operation after certification by the Contractor that the installation is satisfactory.

3.4 PANELBOARD, BUS DUCT AND MCC TESTS

A. "Spot Test" all equipment to be operated on the 208/120V system at 500V DC prior to connecting feeders. A minimum insulation resistance of 2000 meg-ohms shall be obtained between all phases and between phase and ground.

3.5 TRANSFORMER (POWER 600V OR LESS) TEST

A. Insulation tests on transformers shall be as follows:

1. 480 Volts High Sides:

"Spot Test" with 1000V DC, high side winding to low side winding and high side winding to ground. 2000 meg-ohm shall be the minimum acceptable insulation resistance.

2. 208/120 Volts Low Side:

"Spot Test" with 500V DC, low side to ground. 2000 meg-ohm shall be the minimum acceptable insulation resistance.

3.6 SPOT TEST

A. "Spot Test" mentioned in this section shall be interpreted as the specific test method of obtaining insulation resistance by applying indicated test voltage for 60 seconds to the equipment or wiring being tested.

3.7 CONTROL WIRING/OUTLET TEST

A. Control wiring shall perform the function as noted in operation methods and/or included schematics and single line diagrams.

B. All 120 volt outlets shall be tested with a Daniel Woodhead Cat. No. 1750 and 1760 tester under the supervision of the Coordinator. Minimum acceptable tension is 4 oz. for NEMA 1-15R, and 5-20R, 6-15R, 6-20R, 7-15R, 7-20R, 14-15R, 14-20R, 15-15R and 15-20R.

END OF SECTION 26 05 10

SECTION 26 05 13 - MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section contains the medium voltage cables (5 KV – 35 KV) and accessories, methods and testing to be provided as required for medium voltage systems. Quantity, type and size of conductors are shown on schedules and/or contract documents.

1.2 QUALITY ASSURANCE

A. All materials and installation shall be in accordance with latest revisions of the following Codes and Standards:

1. National Electrical Code – NEC
2. Institute of Electrical and Electronics Engineers – IEEE Standard 400
3. OSHA 3120

1.3 SUBMITTALS

A. Provide manufacturer's catalog cuts of all cable types used, including splices and terminations.

B. Submit manufacturer's certified test report for all medium voltage cable.

C. Provide listing of manufacturer's proposed testing in the submittal list identified in Section 26 05 05.

PART 2 - PRODUCTS

2.1 MEDIUM VOLTAGE CABLE

A. General Requirements:

1. Shall be new and unused and not over six months old.

2. Ends of cable shall be sealed to prevent entrance of moisture.

3. Cables shall be for the normal environmental conditions of heat, moisture and potential abrasion. Special cables shall be designed to be resistant to other conditions such as chemicals, petroleum products, fire radiation, and rodent or insect attack as specified, scheduled or shown on the Contract Drawings.

4. The cable shall be able to operate continuously at 105°C conductor temperature; it shall have an emergency rating of 140° C and a short circuit rating of 250° C. Emergency

overloads shall be possible for periods of up to 100 hours per year. Five 100 hour emergency overload operations within the life time of the cable shall be possible.

5. Contractor shall order sufficient cable footage to allow for splices, proper terminations at equipment, and training cables in manholes.

B. Ratings:

1. Voltage Rating 15 KV.
2. Insulation Thickness 133 percent insulation level.

C. Construction:

1. Single conductor.

2. Size #2 AWG to 2,000 MCM Class B stranding, as noted on Contract Documents.

3. Copper conductor, soft drawn. Conductors tin or alloy coated.

4. 105°C conductor temperature rating 140° C conductor emergency conductor temperature rating.

5. Extruded non-conducting covering applied between conductor and insulation and shall be compatible with insulation.

6. Rubber-like insulation vulcanized and applied uniformly to nominal thickness as follows:

RATED VOLTAGE	INSULATION THICKNESS IN MILS INSULATION LEVEL	
	100%	133%
5 kV	119 mils	115 mils
8 kV	115 mils	-----
15 kV	175 mils	220 mils
25 kV	260 mils	320 mils
35 kV	345 mils	420 mils

7. No voids or inclusions of foreign material shall be in insulation.

8. Cross-linked polyethylene not acceptable.

9. A semi-conducting tape shall be applied over the nonconducting insulation covering.

10. Shielded cables are to be insulated with Single Permashield® insulation system or equal.

11. A zinc, tinned copper shielding tape shall be applied over the semi-conducting tape.

12. A seamless extruded jacket of PVC or vulcanized neoprene shall be applied overall to an average thickness of 80 mils for cable up to and including 500 KCMIL, 110 mils for cable size 750 KCMIL and 1000 KCMIL. Minimum thickness shall not be less than 80% of the average thickness and shall conform to Part 4 of ICEA.

13. Outer jacket shall be surface printed with manufacturer's name year of manufacture, voltage and cable size.

14. Make: Kerite, G.E., Okonite, Phelps Dodge, Anaconda, ITT Royal or approved equal.

2.2 MEDIUM VOLTAGE TERMINATIONS AND SPLICES

A. Splices and Connectors:

1. Splice kits to be voltage class, current rating, withstand rating, and type for cable and location of splice as recommended by cable manufacturer, required for system and shown on contract drawings.

2. Verify cable diameter, shielding type, insulating, outside diameter, ground lead size, all necessary parameters prior to ordering splice or connector materials.

3. Provide grounding device, as required to accommodate cables.

4. Premolded separable connectors shall be used for manhole splices as shown on contract drawings.

5. Provide all necessary dead-end connectors required for separable connector system.

6. Separable Connectors Make: Elastimold 600 Series Deadbreak or approved equal.

7. Splices Make: Elastimold, Kerite or approval equal.

8. Splices shall be made only where shown on the drawings or where approved by the Engineer.

B. Terminations:

1. All terminations at switchgear and primary switches shall be made using 15 KV Class terminating kits for metallic tape shielded cable.

2. Make: Elastimold or approved equal.

2.3 FIREPROOFING TAPE

A. Tape shall consist of a flexible conformable fabric which has one side coated with a flame-retardant, flexible, polymeric coating and/or a chlorinated elastomer.

B. Use not less than 0.05 inch thick tape, weighing not less than 2.5 pounds per square yard.

C. Tape shall be noncorrosive to the cable sheath, shall be self-extinguishing and shall not support combustion.

D. Tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

E. Use tape compatible with cable jacket.

F. Make: Minnesota Mining & Manufacturing "Irvington" Brand 7700, with Scotch #27 glass cloth binding type or approved equal.

2.4 TERMINATING FITTINGS

A. Use only two bolt, long-barrel, solderless compression, copper bodied type lugs for copper cable, with NEMA drilling, approved for use at all terminations.

B. The fittings shall be the proper size for the cables and wires being terminated.

PART 3 - EXECUTION

3.1 MEDIUM VOLTAGE CABLE INSTALLATION

A. Pulling

1. Cables may be safely handled in temperatures as low as 20° F. Cable, if it has been exposed to temperatures below 0° F for a 24 hour period prior to pulling in, should be conditioned in a warm location (70° F or higher) for a minimum of 24 hours prior to the start of the pull.

2. Pull all cable in accordance with manufacturer's recommendations and do not exceed maximum pulling tension.

3. Prepare conduit and ducts prior to pulling in cable as follows:

a. For all active ducts, prior to installing cables, thoroughly clean with suitable brush, mandrels and swabs.

b. For all spare ducts, brush and mandrel ducts. Mandrel must trail a 3/16" polypropylene rope, which is to be left in place in duct after mandrel is pulled through.

c. The Owner or his representative shall witness pulling of 3-3/4" O.D. x 6" long mandrel through all 4" ducts, 4-3/4" x 6" long mandrel through all 5" ducts.

d. Seal the ducts and conduit at building entrances, manholes, and at terminations for equipment, including spare ducts and conduit, with a suitable compound to prevent moisture and gases from entering building through conduit.

e. Building interior conduit need not be sealed, unless one end of conduit originates a point outside the building walls, or unless noted on Contract Documents.

4. Cable shall not be bent sharper than twelve (12) times cable diameter.

5. Provide proper and ample mechanical protection in all areas where cable is subject to possible mechanical damage.

6. Use only a water based cable pulling lubricant that is recommended by the cable manufacturer such as Polywater. Use "elephant's trunks" to guide cables; inspect and lubricate during pull.

7. Discard portion of cable enclosed by pulling attachment.

8. Cable ends shall be properly sealed against ingress of moisture and mechanically protected against damage until splices and terminations are completed (time period between cable pull and make-up of splices and terminations).

9. Properly train all cables at termination points with slight curvature to take stress associated with thermal dimensional changes.

10. Cable support intervals shall not exceed 36 inches, unless otherwise shown. Provide adequate slack in the cables and adequate space between circuits.

11. Neatly support cables at all locations and by racks in manholes. Each rack shall have cable support insulators.

12. Assume full responsibility for any damage to existing cables and to electrical system that may occur due to working in existing manholes, cable vault or medium voltage equipment.

13. Unless otherwise specified, use pull ropes, not wire or cable, to install cables in conduit.

B. Positioning of Cables (Terminals)

1. There shall be no bends in the area of the stripped back tapes and coverings.

2. Clearances between cable surfaces and the apparatus to which the cables are connected shall have a minimum separation between surfaces of bare insulation or shielding seals per circuit voltage. This also applies to the separation between the skirts of the hoods of different phases.

3. Clearances below skirts of hoods should be a minimum of 8".

4. Care should be taken to position the lug on the cable so that when the lug is finally fastened to the apparatus there will be no twisting of cable.

5. At splices there shall be no bends or supports in the hand taped section of the splice.

C. Splicing and Terminations

1. Only qualified persons shall perform medium voltage cable splicing and terminations. Such persons must have attended splicing school or have completed equivalent training approved by the Owner or his representative.

2. All terminations and splices shall be adequately supported.

3. Properly phase out and identify all cables before connecting.

4. Make all terminations and splices using materials and connectors as specified and in accordance with manufacturer's instructions.

5. Insulation penciling shall be done carefully and precisely with a sharp knife.

6. The cable shall be installed with no splices unless otherwise noted on contract documents.

7. Clean preservative compounds out of lugs prior to cable termination.

8. Terminations shall comply with the manufacturers recommended torquing values.

3.2 CABLE FIELD TESTING

A. General

1. When all terminations and splices have been made, all newly installed cables or re-terminated existing cables shall be DC hi-potential acceptance tested prior to connections to equipment. Follow all “look out/tag out procedures as required by OSHA.

2. All potential testing shall be performed by the contractor and in the presence of the Owner or his representative.

3. DC hi-potential field testing is primarily a "go, no-go" test. The measured leakage current is very dependent on temperature, humidity and length of cable. A practical criteria for cable acceptance is a decrease in leakage current over time once the maximum steady state voltage is reached. The Owner or his representative shall be the sole judge of the test's acceptability.

4. If found to be defective by these tests, all new cables, terminations or splices when furnished and installed by this contractor, shall be replaced by the contractor at no cost to the Owner.

5. Notify the Owner and his representative when tests are scheduled; provide minimum of two (2) weeks advance notification.

6. Contractor shall use cable testers standard "DC Hi Potential Testing Report" to record field test. Submit three (3) copies of each test report to the Owner's representative.

7. Prior to conducting the DC hi-potential test, contractor shall check cables for correct phasing, continuity, insulation integrity, short circuits or ground faults.

8. Contractor shall be responsible to exercise suitable and adequate safety measures prior to, during and after the high potential tests, including but not limited to: wearing personnel protective equipment, placing warning signs, and preventing people and equipment from being exposed to the test voltage.

B. DC Test Voltages

Rated Voltage	Maximum DC Field Test Voltages in kV			
	New Cable		Existing Cable	
5	28	36	9	11
8	36	44	11	14
15	56	64	18	20
25	80	96	25	30
28	84	100	26	31
35	100	124	31	39

C. Preparatory Steps to DC Testing

1. Cable to be tested must be disconnected from switchgear, transformers, lightning arresters, etc. at each end so that voltage is applied only to cable length being tested. Properly clean ends of conductor. Use solvent recommended by cable manufacturer, if required.

2. Adequate safety shall be taken so that personnel can not come into contact with ends when test is being made.

3. Each cable shall be given a continuity test and identified with phase designation (A, B, C).

4. The cable ends opposite to the end of which the test set is going to be connected shall be completely sealed to prevent corona from forming at sharp ends of cable. Use a plastic bag filled with air and fastened to termination by rubber bands, or use plastic food wrap over terminal end forming as smooth a cone shape as possible, or a mason jar with opening sealed.

5. Ground all shields to the same ground point. No. 6 AWG solid wire is usually adequate. Do not use stranded wire.

6. Connect high voltage lead of test set to cable being tested. Seal connection to prevent corona from forming.

7. Cables not being tested are to be grounded to the same common ground as the shields.

8. Connect and set up controls of Hi-Pot tester as recommended by test set manufacturer.

9. Make final safety check as follows:

   a. Cable ends supported securely and hanging free of all equipment.
   b. Ends are guarded and protected.

c. All grounds are secure.
d. All personnel are clear.

D. DC Test Procedure

1. Raise test voltage to first step slowly. There should be initial charging current which indicates that the test set is properly connected. If there is a ground on the system, a high current will flow immediately and possibly the overload relay of the test set will open. Record leakage current after 15 seconds on test report. (Current reading should be decayed to a constant value after 15 seconds.)

2. Raise the test voltage slowly to the second step. Record leakage current after 15-30 seconds on second step. (Again current reading should be decayed to a constant value after 15-30 seconds.)

3. Raise the test voltage slowly to the third step. Record leakage current after 15-30 seconds on third step. (Again current reading should be decayed to a constant value after 15-30 seconds.)

4. Raise the test voltage slowly to the fourth step. Record leakage current after 15-30 seconds on the fourth step. (Again current reading should be decayed to a constant value after 15-30 seconds.)

5. Raise the test voltage slowly to the fifth step. Record leakage current after one (1) minute on the fifth step.

6. Raise the test voltage slowly to the sixth step. Record leakage current after one (1) minutes on the sixth step.

7. Raise the test voltage slowly to the seventh step. Record leakage current after one (1) minutes on the seventh step.

8. Raise the test voltage slowly to the eighth step. Record the leakage current after one (1) minute on the eighth step and one (1) minutes intervals for the next six (6) minutes.

9. Reduce DC test voltage to zero, turn off DC test set, remove high voltage test leads, and ground tested cable after sufficient capacitive charge in cable has bled off. DO NOT ground cable until voltage has reduced to less than 3000 volts.

NOTE: If curve test voltage vs. leakage current indicates a definite knee in curve, discontinue test. Find and correct fault and consult with the Owner's representative on further testing. Do not exceed 15 minutes total time for any DC test.

3.3 FIREPROOFING INSTALLATION

A. Install fireproofing on medium voltage cables installed in all manholes unless otherwise shown or specified.

B. Install fireproofing on medium voltage cables where more than one circuit occupies the same area (no barrier).

C. Install fireproofing tape over all permanent cable splices.

D. Completed installations of fireproofing shall be capable of withstanding a 200 ampere arc for 30 seconds.

E. Provide fireproofing on each individual cable as follows:

1. Install tightly applied layers of fireproofing tape, approximately 1/16" thick by 3" wide, applied spirally around each cable in one half-lapped wrapping or in two butt-jointed wrapping with the second wrapping covering the joints in the first wrapping.

2. Install the tape with the coated side towards the cable and extend it not less than one inch into each duct.

3. Install random wrapping of glass cloth tape, around the installed fireproofing tape to prevent it from unraveling.

3.4 CABLE IDENTIFICATION

A. Phase Identification:

1. Identify all medium voltage phase conductors in each manhole and switchgear section by applying moisture proof 4" wide tape color band as follows:

a. Phase "A" – black tape
b. Phase "B" – red tape
c. Phase "C" – blue tape

2. Apply tape prior to energizing circuits.

3. Apply tape over cable jacket or fireproofing – not on insulation or stress cones.

B. Cable Identification:

1. Identify all medium voltage cables in each manhole, junction or pullbox, and switchgear section using phenolic tags fastened by nylon ties with the following information:

a. Cable numbers or circuit origination as shown on the contract documents. (i.e. #7011) (Sub #2).

b. Phase designation by letter. (i.e. ØA)

c. Date when the cable was installed or termination made. (i.e. 10/98)

d. Cable size

2. Tags must be in place prior to energizing circuits.

3.5 HOT PHASE AND ROTATION TESTING

A. Correct phasing and rotation shall be the responsibility of the contractor. Verification of same shall be done in the presence of the Owner's representative. In the event of any improper phasing or rotation, the appropriate circuit will be shutdown and the contractor will correct the problem at his cost.

B. All medium voltage system switching, shutdown, grounding and re-energization activity will be performed by the Contractor.

C. Contractor shall perform hot phasing and rotation checks at locations specified in contract documents. The electricians performing these duties must be experienced in this type of activity.

D. The following personal protective equipment shall be worn by personnel performing medium voltage hot phasing: hard hats, safety glasses with side shields, 15 KV class rubber gloves inside leather gloves. All jewelry is to be removed from hands and neck, or any other body parts.

E. Hot Phasing Procedure:

1. De-energize the circuits
2. Remove the covers at the location to be hot phased
3. Set up for hot phasing test. All personnel clear of the area
4. Energize the circuits
5. Perform hot phase test
6. De-energize the circuits
7. Reinstall covers

END OF SECTION 26 05 13

SECTION 26 05 14 - EQUIPMENT CONNECTIONS AND COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide final connections to equipment and coordinate same in accordance with the Contract Documents. Verify all connection types with equipment manufacturer prior to installation.

B. Equipment to receive final connections shall include but not be limited to the following:

1. Motors and Equipment
2. Appliances
3. Owner Furnished Equipment

C. Related work on Division 26

1. Section 26 05 21 – Wire and Cable (0-1000)
2. Section 26 24 19 – Motor Control Center
3. Section 26 29 13 – Enclosed Controllers

D. Related work specified in other Divisions of these specifications.

1. Motors
2. FF & E Package
3. Control Wiring
4. Appliances

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. American National Standard Safety Code for Elevators, Dumbwaiters and Moving Walks (ANSI A17.1).

1.3 QUALITY ASSURANCE

A. Prior to the submitting of bids, the contractor shall familiarize himself with all conditions affecting the proposed installation of equipment requiring electrical connections and shall make provisions as to the cost thereof. Failure to comply with the intent of this paragraph shall in no way relieve the Contractor of performing all necessary work required for final electrical connections and equipment and the coordination thereof.

B. Connections shall be made in accordance with the manufacturers' recommendations and approved shop drawings.

1.4 COORDINATION

A. Prior to ordering breakers, switches, fuses, wire, conduit or any equipment required for connection to equipment supplied by the Owner, this Contractor or other trades, verify the exact current, phase, voltage and frequency of that equipment to assure the proper equipment is provided for said connections. Failure to do so, shall be cause for the Contractor to provide the proper rated equipment at his expense including all labor, material, taxes, freight, restock charges and any other costs associated with providing the proper installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Only those products listed in Division 26 shall be employed.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Connections for a coordination of motors and equipment requiring electrical connections shall include but not be limited to the following:

1. Install motor controllers and disconnect switch for each motor and each piece of equipment.

2. Verify that the motor rotation is correct and reconnect if necessary.

3. Provide separate ground wires in flexible, metal conduit and non-metallic conduit so as to provide an electrically continuous ground path. Ground all equipment.

4. Provide motor branch circuit conductors and connections to each individual motor controller and from each controller to the motor through an approved disconnect switch. Make final connection in minimum 24 inch length of liquid tight, flexible, metal conduit.

5. Provide all necessary wiring and connections for interlocking, remote and automatic controls. Installation of equipment and wiring shall be in compliance with shop drawings and manufacturer's recommendations.

6. Where equipment is fed from branch circuit routed in or under the slab, terminate branch circuit at J-box on 2 foot rigid conduit stub-up and make final connection to equipment in liquid tight, flexible, metal conduit. Provide suitable knee brace on conduit stub-up.

7. Where equipment is fed from overhead support conduit feeder descending from ceiling on flanged floor fitting with conduit type fitting connecting to motor with 24-inch minimum of liquid tight flexible steel conduit.

8. Where nameplate on equipment indicates fuse protection the disconnecting means shall be equipped with time delay fuses.

9. Verify all receptacle types with equipment prior to installing.

3.2 APPLIANCES

A. Connections for and coordination of appliances shall include but not be limited to the following:

1. The basic requirements for motors and equipment specified above shall apply where applicable.

2. Where cord and plugs are provided with the appliances this contractor shall coordinate the receptacle installation to match. Information on the Drawing as to receptacle type is for bidding purposes only.

3. Direct connected equipment shall be serviced by disconnecting means.

3.3 OWNER FURNISHED EQUIPMENT

A. The requirements for equipment furnished by the Owner for installation by this contractor shall include but not be limited to the following:

1. The coordination of the proper delivery scheduling of such equipment.

2. The receiving and unloading of such equipment at the property line.

3. The inspection of such equipment for damages, defacement, corrosion, missing components, etc. at the job site. All deficiencies shall be recorded. Deficiencies occurring after inspection shall be corrected by this contractor at his cost.

4. The safe handling and secure storage of such equipment from unloading to the time of permanent installation.

5. The completion of field make up of internal wiring as required.

6. The lamping of equipment.

7. The installation of accessories on such equipment.

8. The installation of such equipment including the transportation of the equipment to the installation area, and the installation of all supports, fasteners, canopies, extension, etc. required to insure safe support and adaptation to the finished structural, electrical and architectural conditions.

9. The final connections and grounding to the building electrical system including all necessary labor and materials including but not limited to junction box extensions, lug change outs, etc.

10. The testing of such equipment in its final location.

3.4 VARIABLE SPEED DRIVES

A. Where variable speed drives are utilized for control, the following shall be included in addition to other requirements in this Section:

1. Wiring: Install incoming and outgoing power circuits. All outgoing circuits shall be run in individual conduits. No two shall be run in the same conduit. Make final connections to motor.

END OF SECTION 26 05 14

SECTION 26 05 15 - CEILING, FLOOR AND WALL ELECTRICAL PENETRATION FIRE SEALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide premixed putty sealant at ceiling and/or floor electrical penetration fire seals in accordance with the Contract Documents.

B. Related Work Specified in Division 26:

1.	Raceways and Boxes	Section 26 05 33
2.	Enclosed Bus Assemblies	Section 26 25 00
3.	Wires and Cable (0-1000V)	Section 26 05 21

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. ASTM E119-73
2. UL 1479

1.3 SUBMITTALS

A. Submit manufacturer's data for fire seal compound

B. Submit proof of approval by local authorities.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Nelson Electric

2.2 The system shall provide an immediate fire seal, require no curing time, emit no hazardous or toxic fumes and be asbestos free.

2.3 The system shall be easy to use, require no special tools and shall be capable of being installed from one side.

2.4 The system shall not require derating whatsoever of the wiring systems passing through the seal.

2.5 The system shall be field-modified for additions or deletions of raceways or cables.

2.6 Existing materials must be reusable to accommodate penetration changes.

2.7 The system shall maintain the fire rating of the structure it is protecting.

PART 3 – EXECUTION

3.1 GENERAL

A. Putty shall be installed no thinner than 0.75 inches.

B. A minimum of 0.5 inches of putty shall be placed around each penetrating item. When this is not possible, a cone shall be built up around the penetrating items, using a second layer of putty. Slope the cone at 30 degrees from wall or floor.

C. Wall openings must not have an unsupported space of putty greater than 4 inches and floor openings an unsupported opening of 1.5 inches.

D. Provide ceramic wool temperature rated 2300 degrees F. in conjunction with putty in accordance with the manufacturer's instructions

E. Provide ceramic fiberboard temperature rated 2000 degrees F. in conjunction with the putty in accordance with the manufacturer's recommendation

F. Penetrating items must be firmly anchored prior to the putty installation. Provide all necessary anchor bolts, fittings, etc., as necessary

3.2 INSTALLATION

A. Provide fire seals at all cable, conduit and bus duct penetrations through fire rated walls, floors and ceilings, and where noted on Drawings. Coordinate with architectural and structural drawings for location of fire rated walls.

B. Fire seal shall be installed in accordance with manufacturer's direction to provide a barrier rating equal to or greater than the barrier rating of the wall, floor or ceiling.

END OF SECTION 26 05 15

SECTION 26 05 17 - COMMISSIONING ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. The purpose of electric systems commissioning is to increase the reliability of electrical power systems after installation by identifying problems and providing a set of baseline values for comparison with subsequent routine tests. This procedure is the commissioning plan. Specific areas addressed in the commissioning plan include the verification of the installation of all equipment/components, interface connections between equipment and individual systems, and interconnection drawings.

B. The development of this test plan specific to each system and/or component is key to the usefulness of any maintenance program. The plan consists of the schedule of when acceptance and routine tests should be performed, test forms to be used to record the outcome of the tests which are retained for comparison with previous and subsequent tests, and a listing of the required test devices. Since the results of the commissioning tests become baseline test values to compare with later tests and the results of the routine maintenance tests are compiled to identify any downward trend in performance, it is vital to the maintenance program to have accurate and complete records.

C. To perform the testing, the plan lists all required tests in order of performance and gives a schedule for each test. The work items and schedule depend on many items including the importance and cost of the equipment, consequences of failure, age of equipment, past and future frequency of service, hours of operation, future maintenance availability, environmental conditions, and safety requirements.

1.2 COMPONENT TESTING

A. The reliability of any system is dependent on the interconnection of the equipment and the equipment itself. It is assumed that the detailed and comprehensive individual testing of equipment has been completed before the commencing of commissioning of the system. General testing procedures for the components of the systems described in this specification are addressed in Part 3. Commissioning requirements for the system components are typically provided with the original proposal for the procurement of the equipment. The requirements provided by the equipment manufacturer should be adhered to in addition to the recommended testing herein. Although there are many different components in any electrical system, there are some tests that are common among the equipment. Examples of the common testing procedures include the assembly check, alignment check, grounding verification, insulation resistance tests and polarization index to name a few. These common tests are described in detail in Part 3. Sufficient time should be allocated to define the inspections required, perform the check, and document the results. A review of the system drawings will show major pieces of equipment. Specific procedures should be developed for each test referencing the equipment to be used, drawings to be followed, and step by step procedures with readings to be recorded and forms for the results.

1.3 SYSTEM COMMISSIONING TESTING

A. Electrical systems commissioning is critical to ascertain that a system is installed properly and that it will operate as designed. The commissioning of a system encompasses the individual testing of the related components, the verification of the component interconnection against the drawings, and the functional testing of the system as a whole. The schedule of the tests and inspections is dependent on many aspects of the equipment such as its importance and cost, the frequency of service, hours of operation, environmental conditions, accessibility, and safety requirements. Problems may arise during the testing of the equipment and systems. In order to identify and correct these problems, troubleshooting techniques should be developed. Checking of equipment such as fuses, lights, and breakers for continuity, equipment calibration and settings, and investigating for faulty equipment or connections should be the first troubleshooting steps. For all problems, the equipment and component manuals are consulted for troubleshooting directions. Examples of the possible causes to common problems are shown for each system in the chapters that follow.

1.4 GENERAL SYSTEM TESTING REQUIREMENTS

A. The purpose of electrical testing on systems and their components is two-fold. The first is to check the installation of the equipment and perform component and systems tests to ensure that, when energized, the system will function properly. The second is to develop a set of baseline test results for comparison in future testing to identify equipment deterioration.

B. Each commissioning test should be witnessed and approved by a person not associated professionally with the person performing the test. The individuals who perform the acceptance tests should be certified and/or licensed for the equipment under test. The system should be initially checked for damage, deterioration, and component failures using specific component checks, inspections, and tests defined by the equipment manufacturer. Then the interconnection of the system components should be checked, using de-energized and energized methods, to verify the proper interconnection and operation of the components, including on/off control, system process interlocks, and protective relaying functions.

C. Once the above tests are complete, the system can be energized and operational tests and measurements should be performed.

D. All steps and results of the testing should be carefully documented for review and for use in the future for comparison with the results of future tests. Many of the same component tests initially run will be performed at regular intervals as part of a maintenance program. Provide inspection and checks, perform component testing, verify and check the continuity of wiring, check control functions, calibrate instruments and relays, energize portions of the circuits and check for proper operation in a specific order, and, once complete, perform specific checks and control tests on the complete system during initial period of operation.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. It is important that in any test program the proper equipment is used. The equipment shall be calibrated, in good condition, and used by qualified operators. Any test equipment used for calibration shall have twice the accuracy of the equipment to be tested. Care should be taken to use a quality or regulated power source for the equipment as voltage, frequency, and waveform variation can produce invalid results. All equipment should be operated in accordance with its instruction manual.

PART 3 - EXECUTION

3.1 CIRCUIT SWITCHERS

A. The nameplate on all equipment shall be checked against one-lines and schematics. All equipment shall be carefully examined upon receipt to ensure that no damage has occurred during shipment. A visual inspection of the circuit switcher and associated hardware shall be made including nameplate, parts, drawings, and condition. Any discrepancies should be sent to the manufacturer for a resolution. After installation, the circuit switcher shall be checked to ensure that it has been bolted to its permanent foundation, all shipping braces have been removed, and that it has been properly grounded. The alignment of the disconnect should be checked to ensure that the blade tongue contact enters the jaw contact on center, rotates fully and comes to rest within 1/8” of the stop. The interrupter action should be checked for proper lubrication. The control wiring installation shall be checked per the drawings. The low pressure indicator should be checked by measuring the pressure in psig and recorded along with the ambient temperature at the time the measurement was taken and then comparing this value with the manufactures data. Checks shall be made to insure that the grounding connections have been fully installed. Simulate a fault by activating the protective relay circuit and check electrical operation. Check key interlocks both mechanically and electrically. Testing shall include timing, contact resistance, contact part time and charging motor operation. The timing test shall be performed at the normal operating voltage for both trip command and close command.

3.2 TRANSFORMERS

A. The following test procedures apply to both oil filled and dry type transformers unless otherwise noted. Cast coil transformers are also considered dry type and therefore the following tests apply unless it is noted only to apply to oil filled transformers.

1. Inspection upon receipt: A thorough inspection for the transformer shall be completed upon arrival and before unloading. This inspection shall include a detailed visual inspection of the external of the transformer. Oil filled type transformers are typically filled with either dry air or nitrogen. The pressure condition, nitrogen content and dew point shall be measured before unloading of the transformer. A positive pressure should be maintained on nitrogen blanketed transformers. The oxygen content shall be less that 1%. The seals of the transformer shall be inspected to ensure that they are properly seated. For an acceptable transformer installation it is imperative that the foundation is level. This should be checked well in advance of receipt of the transformer. Containment located under the vault, for the purpose of oil leakage, shall also be

inspected. Upon completion of the equipment inspections, the transformer shall be unloaded and set into its final installation position. The shipping braces shall be removed and it shall then be anchored to its foundation. The bolts (if used) securing the transformer to its foundation shall be checked to ensure they are installed at the proper torque. A visual inspection of the transformer internals shall be performed on air and oil filled transformers filled with nitrogen. Transformers shipped with oil will not need internal inspections unless the electrical testing described below indicates a problem. Then the oil must be drained, inspection performed and repair completed. After the repair is inspected, the transformer shall be filled with clean dielectric fluid in strict accordance with the manufacturer's instructions. The purpose of this internal inspection is to determine that no displacement has occurred in transit or during unloading. Items to be verified include the tap changer, end braces and current transformers (if so equipped). This inspection must be performed with dry air in the main tank. If the transformer has been delivered filled with nitrogen, it must be evacuated from the main tank and replaced with dry air. Personnel performing the inspection must wear clean cotton clothing, mouth covers and oil resistant, clean, rubber soled shoes that contain no metallic parts. All transformer nameplates, wiring and accessories shall be visually inspected and compared against the drawings. These accessories include but are not limited to radiators, fans, bushings and instrument controls.

2. Installation checks: After the preceding inspections have been completed, the transformer shall be assembled. Transformer assembly includes but is not limited to mounting of radiators, fans, bushings, thermometers, oil level indicators, relays and expansion tank. Transformer assembly must be in accordance with manufactures instructions and design drawings. After all of the accessories have been installed, protection circuits shall be wired and checked. A pressure test can now be performed and the transformer filled with oil. The alarm, control and trip settings on temperature indicators shall be inspected to verify that they are set as specified. The cooling pumps shall operate correctly and the fan and pump motors shall have the correct overcurrent protection. Operation of all alarm, control and trip circuits from temperature and level indicators, pressure relief device and fault pressure relays shall be checked. Liquid level in all tanks and bushings shall be verified. Grounding shall be verified. Once the above is complete the following tests shall be performed on insulation resistance, dielectric absorption, polarization index, transformer turns ratio text and power factor text.

3.3 SWITCHGEAR – MEDIUM VOLTAGE TESTING

A. The nameplate on all equipment shall be checked against one-lines and schematics. All equipment shall be carefully examined upon receipt to ensure that no damage has occurred during shipment. A visual inspection of the area where the switchgear is installed shall be performed to confirm that there is adequate aisle space at the front and rear of the equipment for proper ventilation, service and maintenance of the equipment. The switchgear shall be checked to insure it is properly anchored to its foundation.

B. Visually inspect that all high voltage connections are properly insulated.

C. Electrically disconnecting contacts, machined parts, shutter, etc. should be checked for lubrication and operation. The breaker alignment and manual operation shall be checked.

D. All bracing, supports, supports and other temporary ties should be removed from breakers, instruments, relays, etc.

E. Proper fuse sizing shall be verified.

F. Proper voltage and phase connections shall be verified. Special attention shall be given to verify that phases are not reversed, ie. A to C, C to A, etc.

G. Verify correct component and installation of potential and current transformers (CT's and PT's) and control fuse size and check continuity. Also check PT and CT polarity and transformer turns ratios.

H. Verify ground connections are properly made.

I. Verify incoming primary and secondary connected are properly made and checked for shorts or undesired grounds.

J. Verify all equipment that has been removed during assembly has been replaced.

K. Verify relays are coordinated with other relays and the protective devices on the system. Also verify that both relay and protective device settings have been coordinated with local utility company. Local utility shall be consulted before making any connections to the power supply.

L. Verify storage battery is fully charged and provided with an operational charger.

M. All circuit breakers should be checked and prepared as per instruction book.

N. Verify all filters in vent areas are clean and free of shipping or construction material.

O. Upon completion of items above, the insulation resistance and dc ho pit test should be performed with taking precautions to eliminate any damage to electronic controls and/or sensitive equipment attached to the bus. The insulation resistance test should be made on the high voltage circuit to be sure that all connections made in the field are properly insulation. A dielectric test should then be made on the high voltage circuit for one minute at the maximum test voltage. Once completed and passed, the switchgear is ready for energization.

3.4 SWITCHGEAR – LOW VOLTAGE TESTING

A. The nameplate on all equipment shall be checked against one-lines and schematics. All equipment shall be carefully examined upon receipt to ensure that no damage has occurred during shipment. A visual inspection of the area where the switchgear is installed shall be performed to confirm that there is adequate aisle space at the front and rear of the equipment for proper ventilation, service and maintenance of the equipment. The switchgear shall be checked to insure it is properly anchored to its foundation.

B. All switches, circuit breakers, and other operating mechanisms shall be manually exercised to make certain they are properly aligned and operate freely.

C. An insulation resistance test should be performed to make sure the switchgear is free from short circuits and grounds. This shall be done both phase-to-ground and phase-to-phase and with the switches or circuit breakers both opened and closed.

D. Any electrical relays, meters, or instrumentation shall be checked to determine that connections are made properly and the devices function properly.

E. Electrically exercise all electrically operated circuit breakers, and other mechanisms (but not under load), to determine that the devices operate properly. An auxiliary source of control power may be necessary to provide power to the electrical operators.

F. Test the ground fault protection system (if furnished) in accordance with the manufacturer's instructions.

G. Check the settings of the adjustable current and voltage trip mechanisms to confirm that they are at the proper values. Refer to the short circuit coordination study as necessary.

H. Make certain that field wiring is clear of live bus and, where necessary, physically secured to withstand the effects of fault currents.

I. Check to determine that all grounding connections are made properly.

J. Remove all debris; scrap wire, etc., from the switchgear interior before closing the enclosure. Install covers, close doors, and make certain that no wires are pinched and that all enclosure parts are properly aligned to be tightened.

K. Once the above is complete perform an insulation resistance test. Before performing insulation tests precautions should be made to eliminate damage to electronic controls/sensitive equipment attached to the bus. The Insulation Resistance test is described in paragraph 3.3 (0.). Once completed and passed, the switchgear is ready for energization.

3.5 TRANSFER SWITCH TESTING

A. The nameplate on all equipment shall be checked against one-lines and schematics. The transfer switch shall be checked for completeness of assembly. All equipment shall be carefully examined upon receipt to ensure that no damage has occurred during shipment such as loose parts and insulation damage.

B. The switch shall be checked for proper alignment and manual operation.

C. The switch insulation resistance (phase-to-phase and phase-to-ground) shall be measured in normal and emergency positions.

D. The wiring of the potential transformer to the control device should be checked for continuity and the control fuse should be checked to confirm size.

E. The transfer switch should be checked for proper grounding.

F. The timer settings should be checked against design parameters.

3.6 VARIABLE FREQUENCY DRIVES (VFD'S)

A. The nameplate on all equipment shall be checked against one-lines and schematics. All equipment shall be carefully examined upon receipt to ensure that no damage has occurred during shipment. VFD's are controllers used to vary the speed of a motor.

B. VFD's are devices that should never be megger tested.

C. VFD's typically come equipped with internal testing capabilities. Any diagnostic tests shall be performed as indicated in the manufacture's manual.

D. A visual inspection of the VFD, enclosure, nameplates connections and drawings shall be performed. After removal of the VFD enclosure cover, the controller shall be checked for physical damage and any debris from installation such as wire strands shall be removed using clean, dry, low-pressure air.

E. All terminal connections shall be checked for tightness.

F. The VFD should be energized with no connection to the load and diagnostic test should be run.

G. Motors should be tested separately as indicated in the motor paragraph.

3.7 MOTORS

A. The nameplate on all equipment shall be checked against one-lines and schematics. All equipment shall be carefully examined upon receipt to ensure that no damage has occurred during shipment. A visual test of the motor shall be performed to ensure that the motor was not damaged in transit from the factory.

B. Check that no loose items such as shaft keys, couplings, etc. are present.

C. Check all connections for tightness and proper insulation.

D. A mechanical test of the motor shall be performed to check that the motor is free from interference. This is accomplished by first uncoupling the motor from the driven machinery. The motor shaft is then manually rotated. The shaft should rotate freely.

E. Once the above is complete, insulation resistance, power factor and dc hi pot test tests shall be performed.

F. On AC rotating machines, the neutral connection on the stator should be removed and a test of each winding with respect to the other two windings and ground should be obtained. After insulation resistance readings have been made, the test voltage is returned to zero and the insulation is discharged.

G. Hi pot each phase separately with the other two phases and the winding temp detectors grounded. Capacitors and surge arrestors should be disconnected during this test. Once completed and passed, the motor is ready for energized checks.

H. A phase check should first be performed by momentarily energizing or “bumping” the motor to confirm the proper direction of rotation. This will confirm that the correct phase connections have been made. Once the correct phasing is confirmed, the motor is ready for energization.

3.8 CABLES

A. For commissioning of cables, the receipt inspection and testing is performed while the cable is still on the reel. The exposed sections of the cables shall be visually inspected for signs of physical damage, the end caps shall be checked for tightness. The cable types and configuration shall be checked for correctness against drawings and purchasing documents.

B. Continuity tests shall be performed on each conductor and the shield. For power cables, insulation resistance tests are performed between each conductor and each conductor and the shield. The cable installation shall be checked against one-lines and schematics.

C. After installation, the cables shall be inspected for damage, proper trained bending radius, adequate spacing for ampacity, proper installation of fireproofing, proper size, termination, and identification.

D. Conductors shall be checked for continuity. The following tests shall be performed before the cables are energized. They are the insulation resistance (megger) test.

3.9 INSULATION TESTING

A. Perform insulation testing to determine the integrity of the insulation. Apply a high potential voltage to the item and measure the leakage current that may flow to ground. Excessive leakage current is an indication of dielectric breakdown and/or impending failure.

B. Cable and circuit breaker insulation testing shall be performed by applying a direct current (dc) voltage. DC tests are "go no-go" tests.

3.10 PROTECTIVE RELAYS

A. Protective relays shall be set and acceptance tested prior to being placed in service and tested periodically thereafter to be set and acceptance tested prior to being placed in service and tested periodically thereafter to ensure reliable performance. The person performing the test should be given the settings to be applied to each particular relay by the engineer. As all electronic devices, solid state relays should never be subject to hi-pot or megger testing. They typically come equipped with internal testing capabilities. Any diagnostic tests shall be performed as indicated in the manufacturer's manual.

B. The second type is induction disk relays. They are subject to the following tests:

1. Inspection: If recommended or desirable, each relay should be removed from its case (if relay design permits) for a thorough inspection and cleaning. If the circuit is in service, one relay at a time should be removed so as not to totally disable the protection. The areas of inspection are detailed in the manufacturer's instruction manual. These generally consist of inspection for loose screws, friction in moving parts, iron filings between the

induction disk and permanent magnet, and any evidence of distress with the relay. The fine silver contacts should be cleaned only with a burnishing tool.

2. Settings: Prescribed settings should be applied or it should be ascertained that they have been applied to the relay.

3. Pickup Test: In the case of a time-over-current relay, its contacts should eventually creep to a closed position with a magnitude of current introduced in its induction coil equal to the tap setting. The pickup is adjusted by means of the retraining spiral-spring adjusting ring. A pickup test on a voltage relay is made in much the same manner.

4. Timing Test: A timing test should be made on most types of relays. In the case of a time-over-current relay, one or more timing tests are made at anywhere from two to ten times the tap setting to verify the time-current characteristic of the relay. Two timing points should be specified in the prescribed settings. Tests should be made with the relay in its panel and case (when primary current injection is used for testing), and the time test run at the calibration setting.

5. Instantaneous Test: Some protective relays are instantaneous in operation, or might have a separate instantaneous element. In this context, the term instantaneous means "having no intentional time delay." If used, the specified pickup on the instantaneous element should be set by test. Again referring to the relay used in the example above, at two times pickup, its instantaneous example above, at two times pickup, its instantaneous element should have an operating time of between 0.016 and 0.030 seconds.

6. Test of Target and Seal-in Unit: Most types of protective relays have a combination target and sealing unit. The target indicates that the relay has operated. The seal-in unit is adjustable to pickup at either 0.2 or 2.0 amperes. The pickup setting is established by the relay coordination study. The setting for the seal-in unit should be specified with the relay settings. It should be verified by test that the contacts will seal in with the minimum specified direct current applied in the seal-in unit.

7. Test of Tripping Circuit: A test should be made, preferably at time of testing the relays, to verify that operation of the relay contacts will cause the breaker to trip.

END OF SECTION 26 05 17

SECTION 26 05 21 - WIRES AND CABLES (0-1000V)

PART 1 - GENERAL

1.1 DESCRIPTION

A. General

1. Provide 600-volt wire and cable in accordance with the Contract Documents.

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. General: Underwriters' Laboratories labeling of all insulations and jackets.

2. Rubber Insulated Wire and Cables

   a. ICEA pub. No. S-19-81 (NEMA Pub. No. WC 3): Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

   b. UL 44: Rubber-Insulated Wires and Cables

3. Thermoplastic Insulated Wire and Cables

   a. ICEA pub. No. 1 S-614-02 (NEMA Pub. No. WC3): Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

   b. UL 83: Wires, Thermoplastic-Insulated

4. Cross Linked Thermosetting Polyethylene Insulated Wire and Cables

   a. ICEA pub. No. S-66-524: (NEMA Pub. No. WC7): Cross Linked Thermosetting Polyethylene Insulated Wire and Cable for Transmission and Distribution of Electrical Energy.

   b. UL 44: Rubber Insulated Wires and Cables

   c. UL 854: Service-Entrance Cables.

5. Annealed Copper Wire for Conductors

   a. ASTM B-3: Soft or Annealed Copper Wire

6. Terminal Blocks

   a. UL 1059

7. Insulation Thicknesses for Individual conductors

a. N.E.C. Table 310-13: Conductor Application and Insulations.

1.3 SUBMITTALS

A. Provide listing of manufacturers proposed in the submittal list identified in Section 26 05 05 of these specifications.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver wire and cable to job site on reels or coils marked in accordance with N.E.C. Section 310-11.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Wire and Cable:

1. Anaconda
2. General Electric Company
3. Hatfield Wire and Cable
4. The Okonite Company
5. Kerite Company
6. Paranite Wire and Cable Division of Essex
7. International, Inc.
8. Pierelli Cable Corporation
9. Phelps Dodge Copper Products Corporation
10. Reynolds Metal Company
11. Rockbestos Products – Cerro Wire and Cable Company
12. Rome Cable Corporation
13. Cyprus Wire and Cable Company
14. Southwire Company
15. Triangle Conduit and Cable Company.

B. Connectors (UL Approved):

1. Hand-Applied:

a. T&B "Piggy"
b. 3M Company "Scotchlok"
c. Ideal Industries "Wing Nut"
d. Buchanan "Squeeze On"

2. Tool-Applied:

a. T&B "Stakon" or Series "54475" through "54490"

b. Ideal Industries "410 Crimp Connector"
c. Burndy "KA-U" or "YA"
d. ILSCO "TA", or "AU" or "D"
e. Buchannan "Wrap Cap"

C. Electrical Tape

1. W.H. Brady "B-500+", "B-500"
2. T&B "E-Z" code Type WBC
3. 3M "Scotch 35" vinyl plastic, electrical
4. Johns-Manville

2.2 WIRE AND CABLE

A. General

1. Provide wire with a minimum insulating rating of 600 volts, except for wire used in 50 volts or below applications for control of signal systems, use 300 volt minimum. Where permitted to be incorporated with other wiring systems, 600 volt wire shall be used for lower voltage wiring systems.

2. Conductor construction and application shall comply with N.E.C. article 310.104. Allowable ampacities shall comply with Table 310.15 (B) (16) or other applicable tables based on temperature and location. In general, wire shall be rated 90° C. Circuits up to and including 100 amperes shall use the 60° C column for ampacities and circuits above 100 amperes shall use the 75° C column for ampacities. For ambient temperatures other than 30° C, use the proper correction factor listed for each table.

B. Conductor

1. Electrical grade, annealed copper, tinned if rubber insulated and fabricated in accordance with ASTM standards. Minimum size number 12 for branch circuits; number 18 for control wiring.

2. The conductors illustrated on the drawings are copper. Except as otherwise noted, aluminum is not permitted.

C. Stranding and Number of Conductors

1. Number 12 and number 10 conductors shall be solid.

2. Cables larger than number 10, stranded in accordance with ASTM Class B stranding designations.

3. Control wires stranded in accordance with ASTM Class B stranding designations.

4. Cables, multi-conductor unless otherwise noted for low-tension systems.

D. Insulated Single Conductors

1. Type THHN – Flame retardant: Heat resistant thermoplastic insulation, nylon jacket rated for 90 C operation. Use for lighting branch circuit wiring installed and passing through the ballast channels of fluorescent fixtures, wiring in metal roof-decks in or near roof insulation in attic or joist spaces, or in raceways exposed to the sun.

2. Type THWN - 75°C: Use in dry or wet locations.

E. Color Coding

1. Provide consistent color coding of all feeders, sub feeders, motor circuits and the likes as follows:

a. 120/208 volts code

1) Phase A – Black
2) Phase B – Red
3) Phase C – Blue
4) Neutral – White
5) Ground – Green

b. 277/480 Volt Code

1) Phase A – Brown
2) Phase B – Orange
3) Phase C – Yellow
4) Neutral – Gray
5) Ground – Green with Yellow Stripe

2. Color-code wiring for control systems installed in conjunction with mechanical and/or miscellaneous equipment in accordance with the wiring diagrams furnished with the equipment. Factory color code wire number 2 and smaller. Wire number 1 and larger may be color coded by color taping of the entire length of the exposed ends.

3. Multi-Conductor Control, Signal and Communication (100 conductors or fewer per cable): In accordance with Table 5-1, Part 5 of ICEA Pub. S-61-402 (NEMA WC 5).

4. Substitutions for Color-Coded Wire: With approval of Owner's Representative and where color coding cannot be readily provided because of limited quantities involved, either of the following:

a. Plastic tape applied spirally and half-lapped over exposed portions of conductors within manholes, boxes and similar enclosures.

b. Colored tubing cut and inserted over ends of wire prior to installing terminals

5. Substitutions for Color Coding for Multi-Conductor Control Cable: Printed conductor identification instead of color-coding is acceptable.

2.3 CONNECTORS

A. Make connections, splices and taps and joints with solderless devices, mechanically and electrically secure. Protect exposed wires and connecting devices with electrical tape or insulation to provide protection not less than that of the conductor

B. Branch circuit wires (number 10 and smaller):

1. Hand-Applied

a. Coiled, tapered, spring wound devices with a conducting corrosion-resistant coating over the spring steel and a plastic cover and skirt providing full insulation for splice and wired ends. Screw connector on by hand.

b. Hydraulic tool of the same lug manufacturer shall be used and hydraulic tool shall emboss on the connector the proper die number for inspection.

2.4 ELECTRICAL TAPE

A. Specifically designed for use as insulating tape.

2.5 LUBRICANT

A. Use lubricant only where the possibility of damage to conductors exists. Use only a lubricant approved by the cable manufacturer and one, which is compatible with cable and raceways.

PART 3 - EXECUTION

3.1 WIRE AND CABLE

A. Provide a complete system of conductors in raceway system. Mount wiring through a specified raceway regardless of voltage application.

B. Drawings indicate the minimum size wiring for branch circuits. Use No. 12 AWG, minimum. For branch circuits whose length from panel to furthest outlet exceeds 75 feet for 120-volt circuits or 175 feet for 277-volt circuits, use number 10 or larger.

C. Do not install wire in incomplete conduit runs or until after the concrete work and plastering is completed and moisture is swabbed from conduits. Eliminate splices wherever possible. Where necessary, splice in readily accessible pull, junction or outlet box.

D. Provide cable supports for all vertical risers where required by code not to exceed the following:

Minimum Conductor Size	Vertical Supports Aluminum	Copper
No. 18 AWG to No. 8 AWG	100 ft.	100 ft.
No. 6 AWG to No. 8 AWG	200 ft.	100 ft.
No. 00 AWG to No. 0000 AWG	180 ft.	80 ft.
250,000 CM to 350,000 CM	135 ft.	60 ft.
350,001 CM to 500,000 CM	120 ft.	50 ft.
500,001 CM to 750,000 CM	95 ft.	40 ft.

E. Flashover or insulation value of joints shall be equal to that of the conductor. Provide Underwriters' Laboratories listed connectors rated to 600 volts for general use and 1,000 volts for use between ballasts and lamps or gaseous discharge fixtures.

F. Use terminating fittings, connectors, etc., of a type suitable for the specified cable furnished. Make bends in cable at termination prior to installing compression device. Make fittings tight.

G. Apply an anti-oxide inhibitor equivalent to "Penetrox" (Burndy) or "Noalox" (Ideal) to all aluminum terminations.

H. Install wire in raceways and make up terminations in accordance with manufacturer's recommendations using special washers, nuts, etc., as required. Use an accepted wire pulling lubricant equivalent to "Yellow" (Ideal) for all wire number 4 and larger. Strip insulation so as to avoid nicking of wire.

I. Extend wire sizing for the entire length of a circuit, feeder, etc. unless specifically noted otherwise.

J. Where multiwire branch circuits (connected to multiple overcurrent devices) are installed in a single conduit, derating adjustments in accordance with NEC 310.15 shall apply. The neutrals shall be counted as current carrying conductors. Shared neutrals are not allowed.

K. Where a three phase circuit consisting of (3) three phase wires, (1) one neutral, and (1) one ground wire connected to a single over-current device is installed in a single conduit, derating adjustments outlined in NEC 310.15 shall not apply.

L. Each main and branch circuit shall have its own neutral conductor. Shared neutral conductors shall not be installed.

M. Conductors and Insulation Applications

1. Service Entrance: Type THHN-THWN, single conductors in raceway.

2. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

3. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

4. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.

5. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, Armored cable, Type AC Metal-clad cable or Type MC metal clad cable where permitted by N.E.C. articles 320 and 330.

6. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in galvanized rigid steel conduit.

7. Fire Alarm Circuits: Type THHN-THWN, in raceway or Power-limited, fire-protective, signaling circuit cable suitable for use in Plenums. Use metal raceways where required in Section 28 31 02 Multiplex Fire Alarm Systems.

8. Class 1 Control Circuits: Type THHN-THWN, in raceway.

9. Class 2 Control Circuits: Type THHN-THWN, in raceway Power-limited cable, concealed in building finishes Power-limited tray cable, in cable tray.

10. Use Type AC/MC cables for fixture whips not to exceed 6 ft. length.

3.2 INSTALLATION

A. General

1. Provide tools, equipment and materials to pull all wire and cable into place and to make required splices and termination.

B. Wire and Cable in Conduit, Duct or Wireway

1. Utilize roller bearing swivel to prevent twisting of cable entering conduit or duct.

2. Take precautions to avoid entrance of dirt and water into conduit and ducts.

3. Clean existing conduits and ducts to remove any pulling compound prior to pulling new cables.

4. Do not damage conductor insulation, braid jacket or sheath.

5. Do not bend conductors to less than manufacturer's recommended radius.

6. Lubricate cable if required for pulling using powdered soapstone or pulling lubricants; do not use oils or greases.

7. Make splices only in pull boxes, junction boxes and outlet boxes.

8. Utilize cable reels on jacks for pulling through pull boxes, ducts and conduits so bends will not be excessive and conductors will not touch sharp edges; use feeding tube where required.

9. For large diameter cables, utilize properly sized pulling grips (open-ended woven basket, two to four feet long, of ductile steel).

10. Do not exceed maximum recommended pulling tension of wire and cable.

C. Splices, Terminations and Connections

1. General: Except where lugs are furnished with equipment, provide terminals and connectors suitable for quantity, conductor size and direction of entry (top or bottom).

2. Insulated Flanged Terminals: Install for connection of conductors No. 12 AWG and smaller to device terminals; do not exceed three terminals at single connections.

3. Circumferential Compression Type Connectors: Install for splices and connections No. 4 AWG and larger.

   a. Use for incoming and outgoing cable connections at enclosures and for ground connections.

   b. Use manufacturer's approved tool and correct hex head which embosses die number on connector lug.

   c. Make crimped indentations parallel with conductor.

   d. Fill voids and irregularities with insulation putty.

   e. Cover neatly with four (4) layers of vinyl plastic tape except where insulated covers are permitted; half-lap tape in two directions.

   f. Use spring-held bakelite covers over splices or taps only with approval of Owner's representative.

4. Conductor Arcproofing

   a. Cover two or more power feeder cables occurring in the same switchboard section, junction box or pull box (including pull boxes over switchboards) with arcproof and flameproof tape, except if boxes or compartments are barriered.

   b. Provide tape "Scotch" Irvington Tape No. 7700 or Plymouth Rubber Co. Slipknot No. 30 to provide an insulation capable of withstanding a 200-amp arc for not less than 30 seconds.

   c. Apply tape in a single layer, half-lapped, or as recommended by the manufacturer to conform to the above requirements. Apply with a random wrap of 1/2 inch (15mm) wide pressure sensitive, plastic film tape color coded as specified in the "conductor identification" paragraph.

D. Wire Marker Identification Labels

1. Utilize labels for all feeders and for those circuits where individual conductor identification is indicated on Drawings.

2. Apply to wires and cables at terminals and in all pull junction and splice boxes.

3. Do not cut and splice multi-conductor control cable for purpose of labeling.

4. Clean surfaces before applying labels.

5. Tag and tape all spare wiring.

3.3 FIELD QUALITY CONTROL

A. Testing

1. Test system wiring for continuity, grounds and short circuits prior to connection of any equipment.

2. Test final equipment connections for proper torque.

3. Insulation Resistance of Feeders and Subfeeders

   a. Test with megger for insulation resistance
   b. Locate faults and replace sections found to have faulty insulation
   c. Demonstrate installation is free of grounds and short circuits and that insulation resistance complies with ICEA values.

4. Test direct burial cables after completion of backfilling.

END OF SECTION 26 05 21

SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide a low impedance grounding system in accordance with the Contract Documents.

1. Purpose of grounding system:

a. Adequate path for ground fault currents.
b. Safety to personnel from accidental electric shock hazards.
c. Prevention of hazardous discharge of static electricity.

2. Whether or not indicated on Drawings, provide continuous ground path for all electrical circuits from point of utilization back to source through ground wires, bonded metallic conduit runs, grounded cable trays, and related items.

B. Electrical Equipment: Provide complete exterior and interior grounding system, including grounding provisions for high and low voltage switchgear and transformers, motor control centers, cable trays, lightning arrestors, motors, emergency generators and other equipment as indicated on Drawings or required by applicable standards.

C. Miscellaneous Equipment: Provide complete grounding for chimneys, smokestacks, flag poles, metal lighting standards, substation fences, metal antennas, supports for elevated metal floors, steel framework of buildings, elevators, and other equipment as indicated on Drawings or required by applicable standards.

D. Related Work Specified in Division 26

1. Section 26 05 10 – Testing, Acceptances and Certifications
2. Section 26 05 14 – Equipment Connections and Coordination
3. Section 26 05 21 –Wires and Cables
4. Section 26 05 33 – Raceways and Boxes
5. Section 26 12 17 – Dry Type Transformers
6. Section 26 12 20 - Pad Mounted Transformers
7. Section 26 13 00 – Medium Voltage Switchgear
8. Section 26 24 13 – Switchboards
9. Section 26 27 26 – Wiring Devices

E. Related Work Specified in Other Divisions of these Specifications.

1. Concrete
2. Metallic water piping

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Underwriters Laboratory Standard No. U.L. 467.
2. ANSI C-1 1978
3. IEEE Standards No. 142-1982 and No. 80
4. National Electrical Safety Code
5. NFPA
6. Federal Information Processing Standards, Publication #94

1.3 SUBMITTALS

A. Provide a complete set of shop drawings showing service grounding methods as called for on the Contract Documents.

B. Submit test reports certifying resistance values for buried or driven grounds and water pipe grounds.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Ground Connectors and Clamps; Grounding Bushings and Locknuts.

1. All Steel Equipment, Inc.
2. Appleton Electric Company
3. Electrical fitting Corp. (EFCOR)
4. Gedney Electric Company
5. lliscol – Div. Of Bardes Corp.
6. Midwest Elec. Mfg. Company
7. Steel City Div., Midland Ross Corp.
8. Thomas & Betts
9. O-Z/Gedney Co.

B. Welding Type Ground Connectors:

1. Burndy Engineering Company (Thermoweld)
2. Erico Products, Inc. (Cadweld)

C. Compression Type Grid Connectors:

1. Thomas & Betts Company – Series, 53,000
2. Burndy Corp. – Cat No. YGL-C

D. Ground Rods and Clamps

1. Copperweld Steel Company

2. ITT Blackburn Corp.
3. J.A. Weaver Company

E. Bonding Jumpers for Hinged-Joints in Cable Tray: Husky/Burndy Cat. No. AF5-C.

F. Electrical Insulating Tapes:

1. Self-Fusing: 3M Company No. 23
2. Vinyl: 3M Company No. 33+

G. Compound for Compression Connectors:

1. Thomas & Betts Co. – Kopr/Shield
2. Brundy Engineering Company – Penetrox "E"

2.2 MATERIALS

A. Ground Cables: Bare or green color coded, insulated, annealed stranded tinned copper wire as indicated on Drawings; insulated wire to conform with requirements of Section 26 05 21.

B. Mechanical Connectors: Tin-plated aluminum alloy, UL approved and stamped for use with aluminum or copper conductors.

C. Ground Rods:

1. Copper-clad steel fabricated by molten welding process
2. Diameter: 3/4 inch.
3. Length: 10 feet

D. Ground Lugs and Connectors for Cable Tray: Tin-plated aluminum alloy suitable for use with aluminum or copper conductors.

2.3 GENERAL

A. Furnish and install electrical grounding systems as indicated on the construction documents and as specified herein.

B. Grounding systems shall be installed in accordance with the requirements of the local authorities, NEC Section 250, and subject to the approval of the Architect/Engineer.

C. Install equipment grounding conductors in all feeders and branch circuits.

D. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.
7. Armored and metal-clad cable runs.

E. All ground wires and bonding jumpers shall be stranded copper installed in conduit. All ground wires shall be without joints and splices over its entire length.

F. The system neutral shall be grounded at the service entrance only, and kept isolated from grounding systems throughout the building.

G. Each system of continuous metallic piping and ductwork shall be grounded in accordance with the requirements of the NEC Section 250.

H. Mechanical equipment shall be bonded to the building equipment grounding system. This shall include but is not limited to, fans, pumps, chillers, etc.

I. Metallic conduits and portions of metallic piping and duct systems which are isolated by flexible connections, insulated couplings, etc., shall be bonded to the equipment ground with a flexible bonding jumper, or separate grounding conductor.

J. Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings and other metal noncurrent-carrying parts that are to serve as grounding conductors shall be effectively bonded where necessary to assure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them. Any non-conductive paint, enamel, or similar coating shall be removed at threads, contact points and contact surfaces or be connected by means of fittings so designed as to make such removal unnecessary.

2.4 SERVICE GROUNDING SYSTEM

A. Provide a bare cooper bus, wall mounted within the electrical switchboard room. Bus shall be 1/4" thick by 2” wide by 4’ long.

B. Extend two (2) service grounding connectors in separate raceways from wall mounted ground bus to extend bus in each switchboard.

C. Extend conductors in raceway from service ground bus to switchboard ground bus as indicated on the drawings.

2.5 SWITCHBOARD, UNIT SUBSTATIONS AND PRIMARY SWITCHGEAR

A. Bond each section of switchboards unit substations and primary switchgear housing and service conduits entering same to ground bus.

2.6 SEPARATELY DERIVED SYSTEMS

A. Equipment grounding conductors shall be provided for separately derived systems and shall be grounded to building steel, cold water pipes, etc., or an alternate grounding means. Equipment grounding shall consist of but not to be limited to the following:

1. Lighting transformer

2. Power transformer
3. Electric generator sets
4. Computer power centers

2.7 RECEPTACLES

A. Receptacles shall be grounded to the outlet box by means of a bonding jumper between the outlet box and the receptacle-grounding terminal.

2.8 MDF/IDF/TELECOM ROOMS

A. In each MDF/IDF/Telecom room, provide a 1/4" x 2" x 2 ft. long copper ground bus, wall mounted on stand-offs and located near the main cable entrances. From each ground bus, run a #6 ground wire to the service entrance ground.

2.9 TELEPHONE /INTERCOMMUNICATIONS ROOMS

A. Incoming telephone terminal board, MDF and IDF rooms shall each be provided with a 1/4" x 2" x 2 ft. #6 copper wire riser between the building service ground and the last riser terminal board. At each terminal riser board provide one (1) #6 bare copper wire from the telephone riser ground and terminating at the riser terminal board, with three (3) feet of spare conductor at the terminal board.

2.10 OUTDOOR EQUIPMENT

A. Outdoor enclosures shall be connected with No. 4 bare copper installed not less than 24 inches below grade, connecting to the indicated ground rods or ground grid. Fence and equipment connections shall be bare copper No. 4. Fence shall be grounded at each gate post and corner post. Each gate section shall be bonded to the fence post through a 1/8-inch by one-inch flexible braided copper strap and approved clamps. Transformer neutral connection shall be sized, based on a separately derived system, N.E.C. table 250.66.

2.11 CONCENTRIC KNOCKOUTS

A. Provide grounding type bushings for conduits terminated through multiple concentric knockouts not fully knocked out, on inside of electrical enclosures. Ground bushing with #12 bare copper to ground bus within enclosure or to enclosure proper where a ground bus is not present.

2.12 LIGHTNING ARRESTORS

A. Lightning (surge) arrestor grounding conductors shall separate from other grounding conductors, but shall have a bond from the equipment ground, at the transformer. Ground conductors shall not be smaller than No. 1/0 cooper AWG for distribution class, and intermediate class. Station-class shall be No. 4/0 AWG. Ground conductors shall be connected to a ground rod. Ground resistance shall not be greater than 25 ohms for distribution-class arrestors, 10 ohms for intermediate-class arrestors, and 5 ohms for station-class arrestors.

2.13 TOGGLE SWITCHES

A. Provide grounding clip on each toggle switch. Mount over device mounting strap such that contact is made between mounting strap, screw, faceplate and outlet box.

B. Provide devices with ground screw where required by local authorities and bond this with #10 conductor to associated outlet box.

2.14 GROUND METHODS

A. Ground rods shall be copper-clad steel not less than 3/4 inch in diameter, ten (10) feet long, driven full length into the earth. The maximum resistance shall not exceed 5 ohms. If this resistance cannot be obtained with a single rod, additional rods shall be installed not less than six (6) feet on center. If sectional type rods are used, two additional sections may be coupled and driven with the first rod.

B. Ufer grounding system shall consist of a bare copper cable minimum forty (40) feet in length placed in the concrete foundation at not more than three inches or less than one inch from bottom, where concrete is in direct contact with the earth.

C. The metal frame of the building, where effectively grounded.

D. The metal underground water piping system used for grounding shall be in direct contact with the earth for ten feet or more and shall be electrically continuous. Provide bonding jumpers at water meter and at insulating joints.

E. Steel reinforcing bars used for grounding shall be encased by at least two inches of concrete, located within and near the bottom of a concrete foundation or footing that is in direct contact with the earth. Reinforcing bars shall be minimum 1/2 inch diameter and consisting of twenty feet of one or more steel reinforcing bars.

F. All bonding jumpers for the above grounding systems shall be sized in accordance with NEC Section 250-102.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Grounding Grid:

1. Install grounding grids with ground rods and cables as indicated on Drawings. At a minimum grounding grid shall consist of a counterpoise layout. Counterpoise shall include (3) 3/4" x 10' long ground rods space 10' apart in a triangular fashion connected together with bare #4 copper cad welded to each rod.

2. Avoid splices in ground cables.

3. Connectors:

a. Install mechanical connectors in above ground accessible locations only.

b. Install welding type ground connections or connection type grid grounding connectors underground, in manholes, or at inaccessible locations only.

c. Thoroughly clean contact surfaces before making connections.

d. Apply manufacturer's compound for compression connectors to conductors prior to crimping.

e. Make connections using compression type grid grounding connectors with approved manufacturer's hydraulic tool and correct size hex head die which, for inspection, embosses proper die number on connectors.

4. Make connection from ground grid to equipment ground buses as shown on Drawings.

5. Provide for future disconnection for testing where building ground loop or grid connects to exterior or interior steel.

6. Wrap conductors with self-fusing electrical tape and cover with vinyl electrical tape where insulation of grounding system connection is required.

B. Cold Water Pipe Grounding:

1. Make connection with clamp type fitting; do not damage water pipe.
2. Bond ground conductor and its conduit to water pipe.

3. Install No. 4/0 AWG bonding jumper with ground clamps around water meter.

C. Ground Conductors:

1. Size as shown on Drawings or as required by NEC Table 250-66 and 250.122.

2. Where ground cables are required, install insulated copper ground conductors in steel conduit, or as indicated.

3. Where ground cable is protected by metallic conduit, bond cable to conduit at both ends.

4. Connect ground conductors in cables and in conduit to appropriate ground buses (as in switchgear, motor control centers, and distribution panelboards) or directly to metallic enclosure if no ground bus is provided.

D. Conduit Attachment to Electrical Equipment:

1. Ground conduits to metal framework of electrical equipment with double locknuts or grounding bushings and bonding jumpers unless otherwise noted.

2. Install bonding jumpers at all electrical equipment to provide continuous ground return path through conduit.

3. Install NEC approved bonding jumpers across expansion fittings between conduit sections for ground path continuity.

4. Bond conduits to cable tray where conduit enters or exits tray.

5. Where motors or other utilization equipment are connected to electrical system with flexible conduit, ground by one of the following:

   a. Flexible metal conduit alone if length is 6 feet or less, conduit is terminated in fitting approved for purpose, and circuit conductors contained therein are protected by overcurrent devices rated 20 at amperes or less.

   b. External jumper across flexible conduit.

   c. Flexible conduit containing integral ground wire.

   d. Do not install external jumpers for flexible conduit connections to kitchen equipment.

E. Receptacles and Switches:

1. Install bonding jumpers between outlet box and receptacle grounding terminal except where contact device or yoke is provided for grounding purposes.

F. Wireways: Install grounding jumpers for bonding between wireway and other panelboards, conduit, switchgear, motor control centers, and at any other point where solid connection would otherwise not be provided in supporting system to insure continuous ground.

G. Panelboards: Install bonding jumpers inside (if possible) all panelboards to bond feeder conduit to panelboards, except ground panelboards containing branch circuits each having less than 150 amperes current carrying capacity, with two standard locknuts and bushings, one inside and one outside, run up wrench tight.

H. Dry-Type Transformers:

1. Perform grounding in accordance with N.E.C. Section 250-30 and Table 250-66.
2. Install bonding jumper across flexible conduit from transformer housing to rigid conduit.

I. Sheet Metal Boxes:

1. Install bonding jumpers inside (if possible) all sheet metal boxes containing one or more feeders with current carrying capacity of 150 amperes or greater, to bond one conduit with another.

2. Ground boxes containing branch circuits only or feeders each less than 150 amperes current carrying capacity, with two standard locknuts and bushings, one inside and one outside, run up wrench tight.

3. Panelboards: Install bonding in sheet metal boxes in systems over 600 volts, regardless of current carrying capacity.

J. Floor Boxes: Install grounding jumpers where adequate ground connections are not provided through locking screws between high potential power service fittings, cover plates and conduit system.

3.2 FIELD QUALITY CONTROL:

A. Resistance Values for System and Equipment Grounds: For each ground rod and ground grid.

1. Acceptable Testing Equipment: Vibroground by Associated Research, Inc.; or Megger Earth Tester by James G. Biddle Co.

2. Method: Three (3) electrode fall of potential as prescribed by instrument manufacturer.

3. Drive additional ten-foot ground rods spaced eight feet apart, if necessary, until total resistance of system is measured at five ohms or less.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Shop Drawings: Show support details if different from methods specified or shown on the drawings.

B. Product Data: Catalog sheets, specifications and installation instructions.

PART 2 - PRODUCTS

2.1 ANCHORING DEVICES

A. Sleeve Anchors (FS FF-S-325 Group II, Type 3, Class 3): Molly/Emhart's Parasleeve Series, Phillips' Red Head AN, HN, FS Series, or Ramset's Dynabolt Series.

B. Wedge Anchors (FS FF-S-325 Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly/Emhart's Parabolt Series, Phillips' Red Head WS, or Ramset's Trubolt Series.

C. Self-Drilling Anchors (FS FF-S-325 Group III, Type 1): Phillips' Red Head Series S or Ramset's Ram Drill Series.

D. Non-Drilling Anchors (FS FF-S-325 Group VIII, Type 1): Hilti's Drop-In Anchor Series, Phillips' Red Head J Series, or Ramset's Dynaset Series.

E. Stud Anchors (FS FF-S-325 Group VIII, Type 2): Phillips' Red Head JS Series.

2.2 CAST-IN-PLACE CONCRETE INSERTS

A. Continuous Slotted Type Concrete Insert, Galvanized:

1. Load Rating 1300 lbs./ft.: Kindorf's D-986.
2. Load Rating 2400 lbs./ft.: Kindorf's D-980.
3. Load Rating 3000 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-H.
4. Load Rating 4500 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-HD.

B. Threaded Type Concrete Insert: Galvanized ferrous castings, internally threaded.

C. Wedge Type Concrete Insert: Galvanized box-type ferrous castings, designed to accept bolts having special wedge shaped heads.

2.3 MISCELLANEOUS FASTENERS

A. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work, selected from the following: Furnish galvanized fasteners for exterior use, or for items anchored to exterior walls, except where stainless steel is indicated.

1. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
2. Lag Bolts: FS FF-B-561, square head type.
3. Machine Screws: FS FF-S-92, cadmium plated steel.
4. Machine Bolts: FS FF-B-584 heads; FF-N-836 nuts.
5. Wood Screws: FS FF-S-111 flat head carbon steel.
6. Plain Washers: FS FF-W-92, round, general assembly grade carbon steel.
7. Lock Washers: FS FF-W-84, helical spring type carbon steel.
8. Toggle Bolts: Tumble-wing type; FS FF-B-588, type, class and style as required to sustain load.

B. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work; Phillips head screws and bolts for exposed Work unless otherwise specified.

2.4 TPR (THE PEEL RIVET) FASTENERS

A. 1/4-inch diameter, threadless fasteners distributed by Subcon Products, 315 Fairfield Road, Fairfield, NJ 07004 (800) 634-5979.

2.5 POWDER DRIVEN FASTENER SYSTEMS

A. Olin Corp.'s Ramset Fastening Systems, or Phillips Drill Company Inc.'s Red Head Powder Actuated Systems.

2.6 HANGER RODS

A. Mild low carbon steel, unless otherwise specified; fully threaded or threaded each end, with nuts as required to position and lock rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.

2.7 "C" BEAM CLAMPS

A. With Conduit Hangers:

1. For 1 Inch Conduit Maximum: B-Line Systems Inc.'s BG-8, BP-8 Series, Caddy/Erico Products Inc.'s BC-8P and BC-8PSM Series, or GB Electrical Inc.'s HIT 110-412 Series.

2. For 3 Inch Conduit Maximum: Appleton Electric Co.'s BH-500 Series beam clamp with H50W/B Series hangers, Kindorf's 500 Series beam clamp with 6HO-B Series hanger, or OZ/Gedney Co.'s IS-500 Series beam clamp with H-OWB Series hanger.

3. For 4 Inch Conduit Maximum: Kindorf's E-231 beam clamp and E-234 anchor clip and C-149 series lay-in hanger; Unistrut Corp.'s P2676 beam clamp and P-1659A Series anchor clip with J1205 Series lay in hanger.

B. For Hanger Rods:

1. For 1/4 Inch Hanger Rods: B-Line Systems Inc.'s BC, Caddy/Erico Products Inc.'s BC, GB Electrical Inc.'s HIT 110, Kindorf's 500, 510, or Unistrut Corp.'s P1648S, P2398S, P2675, P2676.

2. For 3/8 Inch Hanger Rods: Caddy/Erico Products Inc.'s BC, Kindorf's 231-3/8, 502, or Unistrut Corp.'s P1649AS, P2401S, P2675, P2676.

3. For 1/2 Inch Rods: Appleton Electric Co. BH-500 Series, Kindorf's 500 Series, 231-1/2, OZ/Gedney Co.'s IS-500 Series, or Unistrut Corp.'s P1650AS, P2403S, P2676.

4. For 5/8 Inch Rods: Unistrut Corp.'s P1651AS beam clamp and P1656A Series anchor clip.

5. For 3/4 Inch Rods: Unistrut Corp.'s P1653S beam clamp and P1656A Series anchor clip.

2.8 CHANNEL SUPPORT SYSTEM

A. Channel Material: 12 gage steel.

B. Finishes:

1. Phosphate and baked green enamel/epoxy.
2. Pre-galvanized.
3. Electro-galvanized.
4. Hot dipped galvanized.
5. Polyvinyl chloride (PVC), minimum 15 mils thick.

C. Fittings: Same material and finish as channel.

D. UL Listed Systems:

1. B-Line Systems Inc.'s B-22 (1-5/8 x 1-5/8 inches), B-12 (1-5/8 x 2-7/16 inches), B-11 (1-5/8 x 3-1/4 inches).

2. Grinnell Corp.'s Allied Power-Strut PS 200 (1-5/8 x 1-5/8 inches), PS 150 (1-5/8 x 2-7/16 inches), PS 100 (1-5/8 x 3-1/4 inches).

3. Kindorf's B-900 (1-1/2 x 1-1/2 inches), B-901 (1-1/2 x 1-7/8 inches), B-902 (1-1/2 x 3 inches).

4. Unistrut Corp.'s P-3000 (1-3/8 x 1-5/8 inches), P-5500 (1-5/8 x 2-7/16 inches), P-5000 (1-5/8 x 3-1/4 inches).

5. Versabar Corp.'s VA-1 (1-5/8 x 1-5/8 inches), VA-3 (1-5/8 x 2-1/2 inches).

2.9 MISCELLANEOUS FITTINGS

A. Side Beam Brackets: B-Line Systems Inc.'s B102, B103, B371-2, Kindorf's B-915, or Versabar Corp.'s VF-2305, VF-2507.

B. Pipe Straps:

1. Two Hole Steel Conduit Straps: B-Line Systems Inc.'s B-2100 Series, Kindorf's C-144 Series, or Unistrut Corp.'s P-2558 Series.

2. One Hole Malleable Iron Clamps: Kindorf's HS-400 Series, or OZ/ Gedney Co.'s 14-G Series, 15-G Series (EMT).

C. Deck Clamps: Caddy/Erico Products Inc.'s DH-4-T1 Series.

D. Fixture Stud and Strap: OZ/Gedney Co.'s SL-134, or Steel City's FE-431.

E. Supporting Fittings for Pendent Mounted Industrial Type Fluorescent Fixtures on Exposed Conduit System:

1. Ball Hanger: Appleton Electric Co.'s AL Series, or Crouse-Hinds Co.'s AL Series.

2. Flexible Fixture Hanger: Appleton Electric Co.'s UNJ-50, UNJ-75, or Crouse-Hinds Co.'s UNJ115.

3. Flexible (Hook Type) Fixture Hanger: Appleton Electric Co.'s FHHF, or Crouse-Hinds Co.'s UNH-1.

4. Eyelet: Unistrut Corp.'s M2250.

5. Eyelet with Stud: Kindorf's H262, or Unistrut Corp.'s M2350.

6. Conduit Hook: Appleton Electric Co.'s FHSN, or Crouse-Hinds Co.'s UNH-13.

F. Supporting Fasteners (Metal Stud Construction): Metal stud supports, clips and accessories as produced by Caddy/Erico Products Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Where specific fasteners are not specified or indicated for securing items to in-place construction, provide appropriate type, size, and number of fasteners for a secure, rigid installation.

B. Install anchoring devices and other fasteners in accordance with manufacturer's printed instructions.

C. Make attachments to structural steel wherever possible.

3.2 FASTENER SCHEDULE

A. Material:

1. Use cadmium or zinc coated anchors and fasteners in dry locations.

2. Use hot dipped galvanized or stainless-steel anchors and fasteners in damp and wet locations.

3. For corrosive atmospheres or other extreme environmental conditions, use fasteners made of materials suitable for the conditions.

B. Types and Use: Unless otherwise specified or indicated use:

1. Cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.

2. Anchoring devices to fasten items to solid masonry and concrete when the anchor is not subjected to pull out loads, or vibration in shear loads.

3. Toggle bolts to fasten items to hollow masonry and stud partitions.

4. TPR fasteners to fasten items to plywood backed gypsum board ceilings.

5. Metallic fasteners installed with electrically operated or powder driven tools for approved applications, except:

a. Do not use powder driven drive pins or expansion nails.

b. Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.

c. Do not support a load, in excess of 250 lbs. from any single welded or powder driven stud.

d. Do not use powder driven fasteners in precast concrete.

3.3 ATTACHMENT SCHEDULE

A. General: Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of 5.

1. Make attachments to steel bar joists at panel points of joists.

2. Do not drill holes in main structural steel members.
3. Use "C" beam clamps for attachment to steel beams.

B. Where it is not possible to make attachments to structural steel or steel bar joists, use the following methods of attachment to suit type of construction unless otherwise specified or indicated on the drawings:

1. Attachment to Steel Roof Decking (No Concrete Fill):

   a. Decking With Hanger Tabs: Use deck clamps.
   b. Decking Without Hanger Tabs:

      1) Before Roofing Has Been Applied: Use 3/8 inch threaded steel rod welded to a 4 x 4 x 1/4 inch steel plate and installed through 1/2 inch hole in roof deck.

      2) After Roofing Has Been Applied: Use welding studs, or self-drilling/tapping fasteners. Exercise extreme care when installing fasteners to avoid damage to roofing.

2. Attachment to Concrete Filled Steel Decks (Total thickness, 2-1/2 inches or more):

   a. Before Fill Has Been Placed:

      1) Use thru-bolts and fish plates.
      2) Use welded studs. Do not support a load in excess of 250 pounds from a single welded stud.

   b. After Fill Has Been Placed: Use welded studs. Do not support a load in excess of 250 lbs from a single welded stud.

3. Attachment to Cast-In-Place Concrete:

   a. Fresh Concrete: Use cast-in-place concrete inserts.
   b. Existing Concrete: Use anchoring devices.

4. Attachment to Cored Precast Concrete Decks:

   a. New Construction: Use thru-bolts and fish plates before Construction Work Contractor has placed concrete fill over decks.

   b. Existing Construction: Toggle bolts may be installed in cells for a maximum load of 50% of that allowed for new construction.

5. Attachment to Hollow Block or Tile Filled Concrete Deck:

   a. New Construction: Use cast-in-place concrete inserts by having Construction Work Contractor omitting blocks and pouring solid blocks with insert where required.

6. Attachment to Waffle Type Concrete Decks:

   a. New Construction:

      1) Use cast-in-place concrete inserts in fresh concrete.
      2) If concrete fill has been applied over deck, thru-bolts and fish plates may be used where additional concrete or roofing is to be placed over the deck.

7. Attachment to Precast Concrete Planks: Use anchoring devices, except do not make attachments to precast concrete planks less than 2-3/4 inches thick.

8. Attachment to Precast Concrete Tee Construction:

   a. New Construction:

      1) Use tee hanger inserts between adjacent flanges.
      2) Use thru-bolts and fish plates, except at roof deck without concrete fill.

   b. Existing Construction:

      1) Use anchoring devices installed in webs of tees. Install anchoring devices as high as possible in the webs.

   c. Do not use power driven fasteners.

   d. Exercise extreme care in drilling holes to avoid damage to reinforcement.

9. Attachment to Wood Construction: Use side beam brackets fastened to the sides of wood members to make attachments for hangers.

   a. Under 15 lbs Load: Attach side beam brackets to wood members with 2 No. 18 x 1-1/2 inch long wood screws, or 2 No. 16 x 1-1/2 inch long drive screws.

   b. Over 15 lbs Load: Attach side beam brackets to wood members with bolts and nuts or lag bolts. Do not use lag bolts in wooden members having a nominal thickness (beam face) under 2 inches in size. Install bolts and nuts or lag bolts in the side of wood members at the mid-point or slightly above. Install plain washers under all nuts.

LOAD	LAG BOLT SIZE	BOLT DIAMETER
15 lbs to 30 lbs	3/8 x 1-3/4 inches	3/8 inch
31 lbs to 50 lbs	1/2 x 2 inches	1/2 inch
Over 50 lbs to load Limit of structure.	Use bolt & nut	5/8 inch

   c. Bottom chord of wood trusses may be utilized as structural support, but method of attachment must be specifically approved.

d. Do not make attachments to the diagonal or vertical members of wood trusses.

e. Do not make attachments to the nailing strips on top of steel beams.

10. Attachment to Metal Stud Construction: Use supporting fasteners manufactured specifically for the attachment of raceways and boxes to metal stud construction.

a. Support and attach outlet boxes so that they cannot torque/twist. Either:

1) Use bar hanger assembly, or:
2) In addition to attachment to the stud, also provide far side box support.

3.4 CONDUIT SUPPORT SCHEDULE

A. Provide number of supports as required by National Electrical Code. Exception: Maximum support spacing allowed is 4'-0" for conduit sizes 3 inches and larger supported from wood trusses.

B. Use pipe straps and specified method of attachment where conduit is installed proximate to surface of wood or masonry construction.

1. Use hangers secured to surface with specified method of attachment where conduit is suspended from the surface.

C. Use "C" beam clamps and hangers where conduit is supported from steel beams.

D. Use deck clamps and hangers where conduit is supported from steel decking having hanger tabs.

1. Where conduit is supported from steel decking which does not have hanger tabs, use clamps and hangers secured to decking, utilizing specified method of attachment.

E. Use channel support system supported from structural steel for multiple parallel conduit runs.

F. Where conduits are installed above ceiling, do not rest conduit directly on runner bars, T-Bars, etc.

1. Conduit Sizes 2-1/2 Inches and Smaller: Support conduit from ceiling supports or from construction above ceiling.

2. Conduit Sizes Over 2-1/2 Inches: Support conduit from beams, joists, or trusses above ceiling.

3.5 LIGHTING FIXTURE SUPPORT SCHEDULE

A. General: Do not support fixtures from ceilings or ceiling supports unless it is specified or indicated on the drawings to do so.

1. Support fixtures with hanger rods attached to beams, joists, or trusses. Hanger rod diameter, largest standard size that will fit in mounting holes of fixture.

    a. Where approved, channel supports may span and be attached to the underside of beams, joists, or trusses and be utilized for the support of lighting fixtures.

2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).

    a. Where specified that an adequately supported outlet box is to support a fixture or be utilized as one point of support, support the box so that it may be adjusted to bring the face of the outlet box even with surface of ceiling.

B. Specific Installations Where Fixtures May Be Supported From New Ceilings Being Installed By Construction Work Contractor:

1. Support surface mounted fixtures directly from plywood backed gypsum board ceilings.

2. Support surface mounted fixtures directly from framing or furring members of fire rated suspended ceilings (double gypsum board).

3. Support recessed mounted fixtures directly from furring members of furred gypsum board ceilings.

4. Support recessed mounted fixtures directly from the suspension system of suspended acoustical ceilings. Exception: Support each fixture weighing more than 50 pounds (including lamps) independent of the suspended ceiling grid.

5. Deliver documents which state actual fixture weights and indicate fixture locations to the Construction Work Contractor (thru the Director's Representative).

C. Number of Supports for Ceiling Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer, or shown on the drawings.

1. Commercial and Industrial Fixtures:

    a. Support individual fixtures less than 2 feet wide at 2 points.

    b. Support continuous row fixtures less than 2 feet wide at points equal to the number of fixtures plus one. Uniformly distribute the points of support over the row of fixtures.

    c. Support individual fixtures 2 feet or wider at 4 corners.

    d. Support continuous row fixtures 2 feet or wider at points equal to twice the number of fixtures plus 2. Uniformly distribute the points of support over the row of fixtures.

e. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

2. Vandal Resistant, and Minimum Security Fixtures:

a. Support individual fixtures less than 2 feet wide at 4 corners.

b. Support continuous row fixtures less than 2 feet wide at points equal to twice the number of fixtures. Uniformly distribute the points of support.

c. Support individual fixtures 2 feet or wider at each corner and one support midway along each side of longest axis (6 supports total).

d. Support continuous row fixtures 2 feet or wider at points equal to 4 times the number of fixtures. Uniformly distribute the points of support.

e. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

D. Number of Supports for Wall Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer, or shown on the drawings.

1. Commercial and Industrial Fixtures:

a. Support individual fixtures 2 feet long or less at 2 points.

b. Support individual fixtures over 2 feet long at 3 points.

c. Support continuous row fixtures at points equal to twice the number of fixtures. Uniformly distribute the points of support.

d. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

2. Vandal Resistant, and Minimum Security Fixtures:

a. Support individual fixtures 2 feet long or less at 4 points (each corner).

b. Support individual fixtures over 2 feet long at 6 points (each corner and midway along each side of longest axis).

c. Support continuous row fixtures at points equal to 6 times the number of fixtures. Uniformly distribute the points of support.

d. An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

3.6 CHANNEL SUPPORT SYSTEM SCHEDULE

A. Use channel support system where specified or indicated on the drawings.

B. Channel supports may be used, as approved, to accommodate mounting of equipment.

C. Material and Finish:

1. Dry Locations: Use 12 gage steel channel support system having any one of the specified finishes.

2. Damp Locations: Use 12 gage steel channel support system having any one of the specified finishes except green epoxy/enamel.

3. Wet Locations: Use 12 gage steel channel support system having hot dipped galvanized, or PVC finish.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Provide raceways in accordance with the Contract Documents.

B. Related work in other sections:

1. Section 26 05 00 – Common Work Results for Electrical
2. Section 26 05 10 –Testing, Inspection and Certification
3. Section 26 05 15 – Ceiling, Floor, and Wall Electrical Penetration Fire Seals
4. Section 26 05 26 – Grounding and Bonding
5. Section 26 05 29 – Hangers and Supports for Electrical Systems
6. Section 26 05 53 – Identifications for Electrical Systems
7. Section 26 27 26 – Wiring Devices

1.2 REFERENCES

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Rigid Steel Conduit

    a. UL Standards UL-6
    b. A.N.S.I. C80-1
    c. Federal Specification WW-C-581E

2. Intermediate Metallic Conduit

    a. UL Standard UL-1242
    b. Federal Specification WW-C-581E

3. Electrical Metallic Tubing

    a. UL Standard UL-797
    b. A.N.S.I. C80-3
    c. Federal Specification WW-C-563

4. Flexible Steel Conduit

    a. UL Standard UL-1

5. Liquid Tight Flexible Conduit

    a. UL Standard UL-360

6. Non-Metallic Conduit

   a. UL Standard UL-651
   b. A.N.S.I. Standard F512
   c. N.E.M.A. Standard TC-2
   d. Federal Specification GSA-FSS and W-C-1094-A
   e. Corps of Engineers Specification CE-303:01

7. Wireways and Auxiliary Gutters

   a. UL Standard UL-870

8. Rigid Aluminum Conduit

   a. A.N.S.I. C80.5

1.3 SUBMITTALS

A. Provide listing of manufacturers proposed in the submittal list identified in Section 26 05 05 of these specifications.

B. Provide manufacturer's catalog cuts of fittings.

C. Where wireways and/or auxiliary gutters are employed full erection drawings must be submitted. Drawings to include plan views, elevations, size of wireways, type and quantity of conductors, proposed to be installed therein, etc.

D. Indicate duct banks or multi-trade coordinated shop drawings.

E. Submit shop drawings or catalog descriptive data on boxes exceeding twenty-four (24") inches for any one dimension.

F. Submit shop drawings or catalog descriptive for floor boxes and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:

B. Conduit Bodies:

1. Adalet-PLM
2. American Electric
3. Appleton Electric Co.
4. Carlon
5. Crouse-Hinds Division, Cooper Industries, Inc.
6. Delta-Industrial Products

7. Killark Electric Mfg. Co.
8. Kraloy Products Co.
9. O-Z/Gedney
10. Spring City Electrical Mfg. Co.

C. Fittings:

1. Appleton Electric Co.
2. O-Z/Gedney
3. RACO
4. Steel City
5. Thomas and Betts

D. Wireway:

1. GS Metals Corp.
2. Hoffman Engineering Co.
3. Keystone/Rees, Inc.
4. Square D Co.

E. Surface Metal Raceway:

1. B-Line Systems, Inc.
2. GS Metals Corp.
3. Hoffman Engineering Co.
4. Square D Co.
5. The Wiremold Co.

2.2 RACEWAY TYPES

A. Standard Threaded Rigid Steel Conduit

1. Rigid conduit, heavy wall, galvanized.
2. Threaded type fittings: "Erickson" couplings where threaded cannot be used.

B. Intermediate Metallic Conduit

1. Light weight, rigid steel conduit, galvanized.
2. Threaded type fittings: "Erickson" couplings where threaded cannot be used.

C. Electric Metallic Tubing

1. Continuous, seamless tubing, galvanized or sheradized on the exterior, coated on the interior with a smooth hard finish of lacquer, varnish, or enamel.

2. All couplings, connectors, etc., used in conjunction with this raceway, which are two (2") inches in size and smaller shall be steel compression gland fittings, "Tomic" tap-on or "Tomic" compression type. Conduits 2 1/2 inch size and larger may use set screw type which employ four (4) set screws per fitting.

3. EMT is not allowed in concrete.

D. Flexible Steel Conduit

1. Single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel.

2. Maximum length: Six (6) feet.

3. Each section of raceway must contain a bonding wire at each end and sized as required. Provide connectors with insulating bushings.

4. Squeeze-type fittings.

E. Liquid Tight Flexible Electrical Conduit

1. Same as flexible steel conduit except with tough, water-tight plastic outer jacket.

2. Fittings: Cast malleable iron body and gland nut, cadmium plated with one-piece brass grounding bushings which thread to interior of conduit. Spiral molded vinyl sealing ring between gland nut and bushing and nylon insulated throat.

F. Non-Metallic Raceway

1. Composed of polyvinyl chloride suitable for 90 degrees C.

2. Raceway, fittings, and cement must be produced by the same manufacturer who must have had a minimum of ten (10) years experience in manufacturing the products.

3. Materials must have a tensile strength of 7,000-7,200 psi at 73.4 degrees F, flexural strength of 12,000 psi and compressive strength of 9,000 psi.

4. All joints shall be solvent cemented in accordance with the recommendations of the manufacturer.

G. Wireways and Auxiliary Gutters

1. Of sizes and shapes indicated on the drawings and as required.
2. Provide all necessary elbows, tees, connectors, adaptors, etc.
3. Hinged cover secured with captive screws.
4. Wire retainers not less than twelve (12") inches on center.

H. Aluminum Conduit

1. Rigid conduit heavy wall.
2. Threaded type fittings: "Erickson" couplings where threaded cannot be used.

2.3 OUTLET, JUNCTION, AND PULL BOXES

A. Cast Type Conduit Boxes, Outlet Bodies and Fittings

1. Provide surface mounted outlet and junction boxes, in indoor locations, where exposed to moisture and all outdoor locations.

2. Requirements

Type Conduit	Box Material	Type Hubs
Rigid Steel & IMC	Ferrous Alloy	Inside Thread
Electrical Metallic Tubing	Ferrous Alloy or Inside Thread with Adapter	Compression

3. Covers: Cast or sheet metal unless otherwise required.
4. Tapered threads for hubs.

B. Galvanized Pressed Steel Outlet Boxes

1. General

   a. Pressed steel galvanized or cadmium-plated, minimum of four (4") inches octagonal or square, with galvanized cover or extension ring as required.

2. Concrete Box

   a. Four (4") inch octagons with a removable backplate and 3/8" fixture stud, if required. Depth of box shall allow for a minimum of one (1") inch of concrete to be poured above the backplate.

3. Switch and Receptacle Box, Indoors

   a. Nominal four (4") inches square, 1-1/2" or 2-1/8" deep as required, with raised cover unless otherwise indicated on drawings.

4. Lighting Fixture Box

   a. Four (4") inch octagon with 3/8" fixture stud.

   b. For suspended ceiling work, four (4") inch octagon with removable backplate where required, and two (2) parallel bars for securing to the cross-furring channels and extend flexible conduit to each fixture.

5. Plug any open knockouts not utilized.

C. Sheet Steel Boxes Indoors

1. No. 12 USS gauge sheet steel for boxes with maximum side less than forty (40") inches, and maximum area not exceeding 1,000 square inches; riveted or welded 3/4 inch flanges at exterior corners.

2. No. 10 USS gauge sheet steel for boxes with maximum side forty (40") to sixty (60") inches, and maximum area 1,000 to 1,500 square inches; riveted or welded 3/4 inch flanges at exterior corners.

3. No. 10 USS gauge sheet steel riveted or welded to 1-1/2" by 1-1/2" by 1/4" welded angle iron framework for boxes with a maximum side exceeding sixty (60") inches and more than 1,500 square inches in area.

4. Covers

   a. Same gauge steel as box.
   b. Subdivided single covers so no section of cover exceeds fifty (50) pounds.
   c. Machine bolts, machine screws threaded into tapped holes, or sheet metal screws as required; maximum spacing twelve (12") inches.

5. Paint

   a. Rust inhibiting primer; ANSI No. 61 light gray finish coat.

6. Where size of box is not indicated, size to permit pulling, racking and splicing of cables.

7. For Boxes over 600 Volts

   a. Provide insulated cable supports and removable steel barriers to isolate each feeder. Stencil cable voltage class in red letters on the front cover of the box.

   b. Braze a ground connector suitable for copper cables to the inside of the box.

D. Pull and Splice Boxes, Outdoors

1. Aluminum reinforced, with removable covers secured by brass machine screws.

2. Where size of box is not indicated, size to permit pulling, racking, and splicing of the cables.

3. Braze a ground connector suitable for copper cables to the inside of the box.

E. Floor Boxes

1. General

   a. Class 1, water-tight, normal depth cast iron construction Type I, fully adjustable, for use in concrete.

   b. Single Gang Round Type.

   c. Multiple Gang or Combination

      1) Rectangular type partitions for separating power from communication sections.

2. Floor Box Covers

   a. Rugged construction, impervious to cleaning detergents.
   b. Compatible with floor covering.

c. Brass or bronze for flush mounting.
d. Providing continuous ground path to box.

3. Single Gang for 15 or 20 Ampere Duplex Receptacles: Round with four (4), 3/4 inch hubs and single flush cover.

Manufacturer	Floor Box	Carpet Flange	Cover With Flip-Up Disc
Hubbell	B-2536	S-3082	S-3925
Steel City	602	PC-60-CP	P-60-DH
Thomas & Betts	1967 (1" hubs)	1980	202

4. Single Gang for Communication Circuits

a. Round with four (4), 3/4 inch hubs and single flush cover.

Manufacturer	Floor Box	Carpet Combination Flange 2-3/4" Plug	Cover With 3/4" Brushed Standpipe
Hubbell	B-2536	S-3082 S-2525	S-3024
Steel City	602	PC-60-CP	P-60-3/4-2419
Thomas & Betts	1967 (1" hubs)	1980-204	1747

5. Single Gang for Telephone Service

a. Round with four (4), 1-1/4" inch hubs and single flush cover.

Manufacturer	Floor Box	Carpet Cover With Flange 2" Plug	Split Nozzle
Hubbell	B-4233	S-3082 S-2925	S-3086
Steel City	601-1-1/4	PC-60-CP	P-60-2 700
Thomas & Betts	1968 (2" hubs)	1980-204	1725

6. Multi-gang with Interior Partitions and 3/4 Inch Hubs

a. Boxes and Carpet Plates

Manufacturer	Two Gang Box	Carpet Plate (if required)	Three Gang Box	Carpet Plate (if required)
Hubbell	B-4233	S-3084	B-4333	S-3085
Steel City	642	PC-64-2G-CP	643	P-64-3G-CP

b. Single Gang Rectangular Covers for Multi-gang Boxes

Manufacturer	Single Gang Cover	Single Gang Cover With 2" Plug	Single Gang Cover With Combination 2-3/4" Plug
Hubbell	S-3825 (Flip-Up)	S-2825	S-2425
Steel City	P-64-DU (Lift-Up)	P-64-2	P-64-3/4-2

F. Identification Labels

1. Acceptable Manufacturers

a. W.H. Brady Company (Style A)
b. Thomas & Betts Company (T&B), Style A

2. Plasticized Cloth

a. Non-conductive

b. Waterproof

c. Capable of withstanding continuous temperatures of 235 degrees F and intermittent temperatures to 300 degrees F.

d. Overcoating for protection against oil, solvents, chemicals, moisture, abrasion and dirt.

3. Heavy, thermo-resistant industrial grade adhesive, for adhesion of label to any surface without curling, peeling or falling off.

4. Legends

a. Sharp, bold face, two-inch black letters on "Alert" orange background.

5. Label Designations: Nominal System Voltages Applied to the covers of all medium and low voltage pull, splice and junction boxes.

a. 208 volts
b. 240 volts
c. 480 volts
d. 2,400 volts
e. 4,160 volts
f. 12,400 volts
g. 13,200 volts
h. 13,800 volts
i. Other

PART 3 - EXECUTION

3.1 APPLICATION OF RACEWAYS

A. The following applications must be adhered to except as otherwise required by Code. Raceways not conforming to this listing must be removed by this Contractor and replaced with the specified material at this Contractor's expense.

B. Raceway Types — Application

Raceway Types	Application
Rigid Steel	Application: Where installed in concrete within the building, in or under slabs within the building, where exposed to mechanical injury, where specifically required, indoors where exposed to moisture and where required by codes and for all circuits in excess of 600 volts.
I.M.C.	Application: Same as standard threaded rigid steel conduit.
E.M.T.	Application: Use in every instance except where another material is specified. Strictly prohibited in concrete or in contact with earth or fill.
Flexible Steel	Applications: Use in dry areas for connections to lighting fixtures in hung ceilings, connections to equipment installed in removable panels of hung ceilings at bus duct takeoffs, at all transformer or equipment raceway connections where sound and vibration isolation is required. Maximum length: 6'-0".
Liquid-Tight Flexible Conduit	Applications: Use in areas subject to moisture where flexible metal conduit is permitted, at connections to all motors, and all raised floor areas.
Non-Metallic Conduit	Application: a. Schedule 40 – Outside the building, where raceways are in concrete, below grade levels, for raceways in duct banks. b. Schedule 80 – Where specifically called for on the drawings for underground raceways outside of the building which are not encased in concrete. Also for secondary conductors of cold cathode lighting systems.

3.2 RACEWAY SYSTEM IN GENERAL

A. Provide raceways for all wiring systems. All wiring shall be installed in EMT unless otherwise noted or required by Code. 277/480 volt wiring must be kept independent of 120/208 volt wiring. Emergency system wiring must be kept independent of the normal system wiring. Where non-metallic raceways are utilized, provide sizes as required with the grounding conductor considered as an insulated additional conductor. Minimum size, 3/4 inch for branch circuits, and one (1") inch minimum for power distribution. Wiring of each type and system must be installed in separate raceways.

B. Install capped bushings on raceways as soon as installed and remove only when wires are pulled. Securely tie embedded raceway in place prior to embedment. Raceways installed below or in floor slabs must extend a minimum of four (4") inches above the finished slab to the first connector. Lay out the work in advance to avoid excessive concentrations of multiple raceway runs.

C. Locate raceways so that the strength of structural members is unaffected and they do not conflict with the services of other trades. Install one (1") inch or larger raceways, in or through structural members (beams, slabs, etc.) only when and in the manner accepted by the Architect/Engineer. Draw up couplings and fittings full and tight. Protect threads from corrosion with one (1) coat red lead or zinc chromate after installation.

D. Above Grade-Defined as the area above finished grade for a building exterior and above top surface of any slabs (or other concrete work) on grade for a building interior. Above-grade raceways shall comply with the following:

1. Install raceways concealed except at surface cabinets and for motor and equipment connection in electrical and mechanical rooms. Install a minimum of six (6") inches from flues, steam pipes, or other heated lines.

   Provide flashing and counter-flashing for waterproofing of raceways, outlets, fittings, etc., which penetrate the roof. Route exposed raceways parallel or perpendicular to building lines with right-angle turns and symmetrical bends. Run raceways in or under slabs in a direct line and, where possible, with long sweep bends and offsets. Provide sleeves in forms for new concrete walls, floor slabs, and partitions for passage of raceways. Waterproof sleeved raceways where required.

2. Provide raceway expansion joints for exposed and concealed raceways with necessary bonding conductor at building expansion joints and between buildings or structures and where required to compensate for raceway or building thermal expansion and contraction. Provide expansion fittings every 200 feet on outdoor conduit.

3. Provide one (1) empty 3/4 inch raceway for each three (3) spare unused poles or spaces of each flush-mounted panelboard. Terminate empty 3/4 inch conduit in a junction box, which after completion, is accessible to facilitate future branch circuit extension.

4. Provide raceway installation (with appropriate seal-offs, explosion-proof fittings, etc.) in special occupancy area, as required. Provide conduit seal-offs where portions of an interior raceway system pass through walls, ceiling, or floors which separate adjacent rooms having substantially different maintained temperatures, as in refrigeration or cold storage rooms.

5. Provide drag wire in spare or empty raceways. Allow five (5) feet of slack at each end and in each pull box. Tag both ends of wire denoting opposite end termination location with black India ink on flameproof linen tag.

6. Install pull-wire in empty raceways. Use polypropelene on monofilament plastic line with not less than 200 lb. tensile strength. Leave at least 12 inches of slack at each end of pull-wire.

E. No raceway may be installed in a concrete slab except with the permission of the Structural Engineer and with the written consent of the Owner. Conduits embedded in structural concrete slabs shall have the following minimum thickness and shall conform to the following:

Raceway Size	Minimum Thickness of Concrete Slab
3/4"	4-1/2"
1"	5"

1. Unless specifically approved in writing, raceways 1-1/4 inch size and larger, shall not be installed in structural concrete slabs.

2. In no case will installation of raceways be permitted to interfere with the proper placement of principal reinforcement.

3. Raceways in structural slabs shall be placed between the upper and the lower layers of reinforcing steel. This will require careful bending of conduits.

4. Raceways embedded in concrete slabs shall be spaced not less than eight (8") inches on centers and as widely spaced as possible where they converge at panels or junction boxes.

5. Raceways running parallel to slab supports, such as beams, columns, and structural walls, shall be installed not less than twelve (12") inches from such supporting elements.

6. To prevent displacement during concrete pour of lift slab, saddle supports for conduit, outlet boxes, junction boxes, inserts, etc., shall be secured with suitable adhesives.

F. Non-metallic raceway installation shall conform to the following:

1. All joints are to be made by the solvent cementing method using the material recommended by the raceway's manufacturer. To insure good joints, components shall be cleaned prior to assembly. Fittings, cement, and conduit shall be supplied by the same manufacturer.

2. Raceway cut-offs shall be square and made by handsaw or other approved means which does not deform the conduit. Raceways shall be reamed prior to solvent cementing to couplings, adaptors, or fittings.

3. Electrical devices which are served by PVC raceways shall be grounded by means of a ground wire pulled in the raceway.

4. Male box adapters shall be used for all box or raceway fittings to terminate plastic raceways.

5. Where separable terminations are required, they shall be made using PVC Threaded Adapters with lock-nuts or bushings. If such terminations must be water-tight, "O" rings shall be installed.

6. Bends shall be made by methods that do not deform or damage the conduit. The radii of field bends shall not be less than those established by the N.E.C.

7. Raceway expansion fittings shall be provided where necessary. The position of the expansion fitting shall be adjusted proportional to the temperature at installation.

8. Raceway supports shall be installed, in such a manner, to allow the PVC Conduit to slide through the supports as the temperature changes.

9. Elbows must be galvanized rigid steel or intermediate metallic conduit.

10. Non-metallic raceway is not permitted to be installed within the building.

G. Raceways in hung ceiling shall be run on and secured to slab or primary structural members of ceiling, not to lathing channels or T-bars, Z-bars, or other elements which are the direct supports of the ceiling panels. Secure conduit firmly to steel by clips and fittings designed for that purpose. Install as high as possible, but not less than 1'-0" above hung ceilings.

H. Conduit above accessible ceilings and exposed raceways shall be run parallel or at right angles with building lines. Secure raceway clamps or supports to masonry materials by toggle bolts, expansion bolts, or steel inserts. Install raceways on steel construction with approved clamps which do not depend on friction or set screw pressure alone.

I. Clear raceway of all obstructions and dirt prior to pulling in wires or cables. This shall be done with a ball mandrel (diameter approximately 85% of conduit inside diameter) followed by a close fitting wire brush and wad of felt, or similar material. This assembly may be pulled in together with, but ahead of, the cable being installed. All empty raceways shall be similarly cleaned. Clear any raceway which rejects ball mandrel.

J. Support less than two (2") inches trade size, vertically run, raceways at intervals no greater than eight (8) feet. Support such raceways, two (2") inches trade size or larger and made up with threaded couplings, at intervals no greater than the story height, or fifteen (15) feet, whichever is smaller.

K. Support less than (1") inch trade size, horizontally run, raceways at intervals no greater than seven (7) feet. Support such raceways, one (1") inch trade size or larger, at intervals no greater than ten (10) feet.

3.3 WIREWAYS AND AUXILIARY GUTTER

A. Wireways installed in hung ceilings shall be placed such that the cover will hinge upward from the side.

B. Twelve (12") inches clear shall be provided from wireway cover when it is in the open position.

C. Routing of wireways, shown on plans, is diagrammatic. Provide a complete system including corners, elbows, and angle sections to clear the work of other trades and other obstructions.

3.4 OUTLET, JUNCTION, AND PULLBOXES

A. Provide outlet, junction, and pullboxes as indicated on the drawings and as required for the complete installation of the various electrical systems, and to facilitate proper pulling of wires and cables. J-boxes and pullboxes shall be sized per electrical code minimum. Boxes on empty conduit systems shall be sized as if containing conductors of #4 AWG.

B. The exact location of outlets and equipment is governed by structural conditions and obstructions, or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to the room layout and will not interfere with other work or equipment. Verify final location of outlets, panels, equipment, etc., with Architect.

C. Back-to-back outlets in the same wall, or "thru-wall" type boxes, are not permitted. Provide twelve (12") inch (minimum) spacing for outlets shown on opposite sides of a common wall to minimize sound transmission.

D. Fit outlet boxes in finished ceiling or walls with appropriate covers, set flush with the finished surface. Where more than one switch or device is located at one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide Series "GW" (Steel City) tile box, or as accepted, or a four (4") inch square box with tile ring in masonry walls, which will not be plastered or furred. Where drywall materials are utilized, provide plaster ring. Provide outlet boxes of the type and size suitable for the specific application. Where outlet boxes contain two (2) or more 277 volt devices, or where devices occur of different applied voltages, or where normal and emergency devices occur in same box, provide suitable barrier.

E. Types of Boxes and Fittings for Various Locations

Locations	Types
Outlet	Galvanized pressed steel
Outlet exposed to moisture and outdoors	Cast type conduit fitting
Splice	Galvanized press steel

F. Pull Box Spacing

1. Provide pull boxes so no individual conduit run contains more than the equivalent of four (4) quarter bends (360 degrees total).

2. Conduit Sizes 1-1/4" and larger.

   a. Provide boxes to prevent cable or wire from being excessively twisted, stretched, or flexed during installation.

   b. Provide boxes for medium voltage cables so that maximum pulling tensions do not exceed cable manufacturer's recommendations.

   c. Provide support racks for boxes with multiple sets of conductors so that the conductors do not rest on any metal work inside box.

3. Conduit sizes one (1") inch and smaller, low voltage wire and cable (maximum distances).

   a. 150 feet straight runs.
   b. 100 feet runs with one 90 degree bend or equivalent.
   c. 75 feet runs with two 90 degree bends or equivalent.
   d. 50 feet runs with three or four 90 degree bends or equivalent.

G. Sheet Steel Boxes

1. Size and shape (if not on drawings) to avoid exceeding manufacturer's minimum bending radius recommendations for conductors.

2. Access for removal and replacement of conductors, splices, and equipment.

3. Minimum dimensions of boxes in runs of 1-1/2" or larger conduit.

a. Straight Pulls

1) Sizes length eight (8) times nominal diameter of largest conduit.

b. Angle or U Pulls

1) Size such that distance between conduit entry and opposite wall of box is six (6) times nominal diameter of largest conduit.

4. Covers

a. Fasten to flange or framework of box with machine bolts, machine screws threaded into tapped holes, or sheet metal screws as required.

H. Floor Boxes

1. After Concrete Pour

a. As soon as traffic is permitted on slab, remove any accumulation of water and foreign matter to avoid corrosion and rust.

b. Insure covers are flush with finished floor.

c. Install cover plates and accessories after floor finishing materials have been installed; refer to drawings for requirements for carpet flanges, bushed standpipe, split nozzles and type of covers.

I. Identification labels for all low voltage and medium voltage pull, splice and junction boxes in main feeder and subfeeder runs, indicating nominal system voltage.

1. Apply labels after painting of boxes, conduits, and surrounding areas have been completed.

2. Clean surfaces before applying labels; clean aluminum surfaces with solvent wipe.

3. Apply labels on cover and minimum of one (1) fixed side: one (1) label viable from floor where boxes are installed exposed.

3.5 EMERGENCY SYSTEM RACEWAYS IN HEALTHCARE APPLICATIONS

A. The wiring of emergency systems serving patient care areas shall be run in EMT conduit in accordance with NEC 517.30. Flexible conduit is not permitted.

3.6 SLEEVES

A. Where sleeves are required for the installation of electrical work, passing through walls or floors, they shall be furnished and installed under this Section of the specification unless indicated otherwise on the drawings. Such sleeves shall be galvanized or black enameled rigid steel conduit or Schedule 40 black steel pipe. Aluminum conduit sleeves shall not be used. Where specific sizes are not indicated on the drawings, sleeves shall be sized to provide 1/2 inch clearance around the outside surface of the item for which they are installed. They shall be cut flush with wall surfaces and shall extend two (2") inches above finished floor level, or as indicated on the drawings.

B. For interior walls and for floors, the space between conduit, ground cable, or similar items and sleeves shall be packed to the full depth of wall or slab thickness with one of the following:

Material	Manufacturer
All-Purpose Insulating Cement	McMasters-Carr Supply Company
Vermiculite (Plaster Mix)	Vermiculite Products, Inc. Houston, TX 77000 Vermiculite-Intermountain, Inc. 333 West – 100 South Salt Lake City, UT
Perlite (Plaster Mix)	Perlite Manufacturing Company Carnegie, PA 15106 Zonolite Construction Products – Division of W.R. Grace & Company 62 Witamore Avenue Cambridge, MA

END OF SECTION 26 05 33

SECTION 26 05 35 - POKE-THROUGH OUTLETS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide poke-through outlets in accordance with the Contract Documents.

B. Related Work Specified in Other Divisions of These Specifications

1. Carpet tiles
2. Cutting and patching

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. U.L Standard #514

1.3 SUBMITTALS

A. Submit manufacture's catalog cuts and specifications for all poke through outlets.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Hubbell

B. Legrand

C. Steel City

2.2 POKE-THROUGH IN GENERAL

A. All through floor wiring for power and communication shall have a minimum fire rating of 2 hours.

B. All power units shall be factory prewired with 120V, 20 amp rated grounded receptacle, with one divided through floor conduit, a junction box, and shall be self supporting without the attachment of an above floor fitting.

C. All units for power and telephone shall be factory prewired, with 120V, 20A amp rated grounded receptacle, and shall contain internal barrier such that power will occupy one-half of outlet box and telephone the remaining half of the outlet box.

D. The integral fire barrier shall incorporate a cold smoke barrier to prevent the passage of smoke when heat is not present.

E. All units shall be for use with slab floors as well as corrugated metal deck type. All metal boxes shall be provided with corrosion protection suitable for installation in concrete. Aluminum alloy boxes are not considered acceptable for installation in concrete or cinder fill unless protected by asphalt paint or the equivalent.

F. All units shall accept up to 100 pair telephone service cable.

G. Each unit shall be provided with a heavy gauge steelwork plate that is clearly marked – power-telephone. Do not install the service fitting until the floor finishing is completed.

H. Contoured die-cast aluminum, finished cover to be as selected by Architect/Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Electrical contractor to verify the thickness of the floor and select the through floor component that fits floor thickness.

B. Install so that cover plates are flush with top of finished floor.

C. The electrical documents shall not be used for the purpose of establishing locations of floor outlets. The location of such outlets shall be established by the Architect.

END OF SECTION 26 05 35

SECTION 26 05 48 - VIBRATION & SEISMIC CONTROLS FOR ELECTRICAL COMPONENTS

PART 1 - GENERAL

This section provides for vibration isolation as well as seismic control for the "equipment" components as listed below. This specification is part of the general conditions for the Electrical contracts.

1.1 DESCRIPTION

A. Intent

1. All equipment and conduit as noted on the drawings schedule or in the specification shall be seismically braced. Vibration control shall apply as described herein.

2. Seismic bracing and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.

3. It is the intent of the seismic portion of this specification to keep all electrical building system components in place during a seismic event and operational where this specification so requires.

4. All such systems must be installed in strict accordance with seismic codes, component manufacturer's and building construction standards. Whenever a conflict occurs between the manufacturers or construction standards, the most stringent shall apply.

5. This specification is considered to be minimum requirements for seismic consideration.

6. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

B. The work in this section includes, but is not limited to the following:

1. Vibration isolation for conduit and equipment.

2. Equipment isolation bases.

3. Seismic restraints for isolated equipment.

4. Seismic restraints for non-isolated equipment

5. Certification of seismic restraint designs and installation supervision.

6. Certification of seismic attachment of housekeeping pads.

7. All equipment (components) requiring IBC certification.

8. All inspection and test procedures for equipment (components) requiring IBC certification.

9. All electrical equipment and systems within or on the building. Equipment buried underground is included. Entry of services to building, up to but not including the utility connection point is part of this Specification.

   Equipment referred to below is typical. (Equipment not listed is still included in this specification)

   For IBC projects, all systems listed in or part of this paragraph are referred to as components:

   Battery Chargers
   Battery Racks
   Cable Trays
   Computer Room Units
   Conduit
   Curb
   Electrical Panels
   Equipment Supports
   Fire Alarm Panels
   Generators
   Light Fixtures
   Motor Control Centers
   Risers
   Supports
   Switchgear
   Transformers
   Unit Substations
   Variable Frequency Drives
   Vibration Isolators

C. Definitions *(all codes).*

1. Life Safety Systems:

   a. All systems involved with fire protection including control panels and fire alarm panels.

   b. All electrical or systems that support the operation of or are connected to emergency power equipment including all lighting, generators, transfer switches and transformers.

   c. All medical and life support systems.

2. Positive Attachment:

   a. Positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double-sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead electrical equipment are not acceptable on this project as seismic bracing points.

3. Definitions, IBC *(in addition to the above)*

   Anchor: A device, such as an expansion bolt, for connecting conduit bracing members into the structure of a building.

   Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.

   Attachment: See **Positive Attachment** below.

Bracing: Metal channels, cables or hanger angles that prevent conduits from breaking away from the structure during an earthquake. See also Longitudinal Bracing and **Transverse Bracing**. Together, they resist lateral loads from any direction.

Certificate of Compliance: A certificate stating that materials and products meet specified standards or that work was done in compliance with approved construction documents, provided by an approved agency.

Component: A part or element of an electrical system.

Component, equipment: An electrical component or element that is part of an electrical system within or without a building system.

Component, flexible: Component, including its attachments, having a fundamental period greater than 0.06 seconds.

Component, rigid: Component, including its attachments, having a fundamental period less than or equal to 0.06 seconds.

Equipment: Systems associated with ducts, pipes and conduit, also called components.

Hazardous Contents: A material that is highly toxic or potentially explosive and in sufficient quantity to pose a significant life-safety threat to the general public if an uncontrolled release were to occur.

Inspection Certificate: An identification applied on a product by an approved agency containing the name of the manufacturer, the function and performance characteristics, and the name and identification of an approved agency that indicates that the product or material has been inspected and evaluated by an approved agency *(see Section 1703.5 and "Label" and "Manufacturer's Designation" and "Mark")*.

Label: An identification applied on a product by the manufacturer that contains the name of the manufacturer, the function and performance characteristics of the product or material, and the name and identification of an approved agency and that indicates that the representative sample of the product or material has been tested and evaluated by an approved agency *(see Section 1703.5 and "Inspection Certificate" and "Manufacturer's Designation" and "Mark")*.

Lateral forces: A force acting on a conduit in the horizontal plane. This force can be in any direction.

Load: Gravity Load *(W)*: The total dead load and applicable portions of other loads *as defined in Section 1613 through 1622.*

Longitudinal bracing: Bracing that prevents a conduit from moving in the direction of its run.

Longitudinal force: A lateral force that happens to be in the same direction as the conduit.

Manufacturer's Designation: An identification applied on a product by the manufacturer indicating that a product or material complies with a specified standard or set rules *(see also "Inspection Certificate" and "Label").*

Occupancy Importance Factor: A factor assigned to each structure according to its Seismic Use Group as prescribed in the IBC.

Positive Attachment: A mechanical device, designed to resist seismic forces that connects a non-structural element, such as a conduit, to a structural element, such as a beam. Bolts and screws are examples of positive attachments. Glue and friction due to gravity do not create positive attachments.

Seismic Design Category: A classification assigned to a structure based on its Seismic Use Group and the severity of the design earthquake ground motion at the site.

Seismic Forces: The assumed forces prescribed herein, related to the response of the structure to earthquake motions, to be used in the design of the structure and its components.

Seismic Use Group: A classification assigned to a building based on its use as defined in *Section 1616.2.*

Seismic: (adj.) Related to an earthquake. Seismic loads on a structure are caused by wave movements in the earth during an earthquake.

Site Class: A classification assigned to a site based on the types of soils present and their engineering properties as defined in *Section 1615.1.5.*

Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.

Special Inspection, Periodic: The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work has been or is being performed and at the completion of the work.

Special Inspection: Inspection as herein required of the materials, installation, fabrication, election or placement of components and connections requiring special documents and referenced standards *(see Section 1704).*

Story Drift Ratio: The story drift divided by the story height.

Transverse bracing: Bracing that prevents a conduit from moving from side to side.

1.2 QUALITY ASSURANCE

A. For both Non-IBC and IBC Projects substitution of internally or externally isolated and restrained equipment supplied by the equipment vendor, in lieu of the isolation and restraints specified in this section, is acceptable provided all conditions of this section are met. The Equipment manufacturer shall provide a letter of guarantee from their Engineering Department

PE stamped and certified per the section on Seismic Restraint Design (See paragraph 1.3) stating that the seismic restraints are in full compliance with these specifications. Where IBC is required, manufacturer certification shall be in addition to all requirements which are stated in Paragraph 1.3 of Article 4.

Letters from field offices or representatives are unacceptable. All costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment vendor in the event of non-compliance with the proceeding. Internal isolation is not acceptable for:

- Indoor or outdoor mounted equipment over or adjacent to:
  - Patient or operating areas
  - Theatre space
  - Office locations
  - Assembly areas

1.3 SUBMITTAL DATA REQUIREMENTS

A. Refer to Part I General Requirements.

B. The manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:

1. Descriptive Data:

   a. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.

   b. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.

2. Shop Drawings:

   a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

   b. Provide all details of suspension and support for ceiling hung equipment.

   c. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for conduits must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.

   d. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

3. Seismic Certification and Analysis:

   a. Calculations by the Manufacturer's qualified licensed Engineer substantiating the mounting system, seismic restraints and recommended anchor bolts shall be submitted for approval along with the shop drawings. Calculations shall be based on the loads as established in *Section 4d – Design Loads* at the end of this section. All analysis shall be stamped by a registered professional having a PE from the same state as the project.

   b. Unless otherwise specified, all electrical equipment, piping and conduit shall be restrained to resist seismic forces. Restraints shall maintain electrical equipment, conduit in a captive position. Restraint devices shall be designed and selected to meet seismic requirements as defined in the latest issue of:

      - Applicable state and local codes
      - NFPA, (fire protection only).
      - IBC International Building Code (See paragraph 4).

4. International Building Code Additions:

   In addition to all of the above provisions, all trades shall comply with sections 16 and 17 of the International Building Code using only vendors that comply with the provisions stated herein and submitting the special inspections listed within these specifications. Where compliance is not possible, each contractor shall submit a vendor report clearly indicating that none of the specified, listed or other vendors known to the contractors meet the compliance, testing and certification portions of the IBC specifications Section 16 and 17. Special inspections shall still be conducted (Paragraph 4 b) even if no vendors meet the following requirements. All non-isolated and isolated equipment, (components) shall be secured to the structure in accordance with that code.

4a. All component manufacturers will submit for approval the following as required below:

   - All **life safety system** components noted in this specification will have the manufacturer of that component submit the Approved Agencies Certificate of Compliance for the specific equipment on this project when the Seismic Design Category is "C-F". Analytical or Shaker Test certification thru the component's load path including structure at its center of gravity shall include **anchorage, structural** and **online capability**.

   - For **Seismic Hazard Exposure Group III** projects, all components noted in this specification will have the manufacturer of that component submit the Approved Agencies Certificate of Compliance for their equipment when the Seismic Design Category is "C-F". This requirement also pertains to projects that combine an emergency preparedness center within a structure of another Use Group where that component is needed for continued operation of the building or whose failure could impair the continued operation of the building. Note: the definition of the above refers to any component which does not allow or hampers the use or capability of the intended purpose of that structure Analytical or Shaker Test certification through the total component's load path to structure at its center of gravity shall include **anchorage**, **structural** and **online capability**.

- All components containing **Hazardous** or **Flammable** materials will have the manufacturer of that component submit the Approved Agencies Certificate of Compliance for their equipment when used on any project having a minimum Seismic Design Category of "C-F". Analytical or Shaker Test certification through the total component's load path to structure at its center of gravity shall include **anchorage, structural online capability** to insure against loss of hazardous or flammable (explosive) material. Test shall prove that no internal component will fail which could support combustion and/or explosion.

- All **COMPONENTS NOT LISTED IN THE ABOVE CATEGORIES** shall have the manufacturer of each component submit a PE stamped calculation package that their project specific equipment will accept anchorage through the component's load path to structure at its center of gravity at the designated anchorage locations. This requirement is for all projects having a Seismic Design Category of "C-F".

4b. The following systems shall require Special Inspection and Periodic Special Inspection for anchorage during the course of construction, as defined earlier in this section for all buildings in Seismic Design Categories C-F.

- All electrical components for standby or emergency power systems require Periodic Special inspection.*

- All electrical equipment in Seismic Design Categories E and F. (Periodic)*

- All equipment using combustible or toxic energy sources. (Special $^{-1}$)

- All electric motors, transformers, switchgear unit substations and motor control centers. (Special $^{-1}$)

- Reciprocating and rotating type machine. (Special $^{-1}$)

- Isolator units for seismic isolation system (Periodic)*

- Manufacturer's Quality Control Program for projects in Seismic Design Categories E or F.

4c. Contractor Responsibilities and Approvals:

Each contractor responsible for the installation of the components asterisked above, (*) shall be responsible for submitting to the design team for their approval, a written contractor's statement of responsibility as outlined below. In addition all (-1) items above require special inspection in accordance with *IBC Section 1707.7.1.*

- Identify the components that are part of the Quality Assurance Plan. (asterisked above)*

- Identify all Special Inspection and Testing for components installed as part of this contract.

- Listed control procedures within the contractor's organization for all special inspection and testing including methods, frequency of reporting and their distribution of those reports.

- List personnel and their qualifications exercising control over the seismic aspects of the project.

4d. Design loads:

a. Projects located in the states of Connecticut, Delaware, New Jersey, New York and Pennsylvania, have a maximum design load of .4g for statically mounted components and .9g for resiliently mounted components. Actual loads shall be as above or as calculated but shall not be less than .4g for static and .5g for resiliently mounted components including internal components as part of a manufactured system.

b. Exclusions for seismic restraint of piping and duct shall be according to applicable codes. The minimum horizontal restraint capability shall be .4g horizontal and .27g vertical. Life safety equipment defined above shall be designed to survive a horizontal load of .9g and a vertical load of .6g.

c. Testing or calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered PE with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include shear and tensile loads as well as one test or analysis at 45º to the weakest mode. IBC Component testing must be by an Approved Agency.

d. Analysis for anchorage must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in Section 4 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

e. Vertical load shall be calculated at 2/3 the horizontal load.

f. Internally isolated equipment in lieu of specified isolation and restraint systems must meet all of the requirements of paragraph 4 (a-d) and Section 1.6.

g. A seismic design Errors and Omissions insurance certificate **MUST** accompany the equipment manufacturer's certification. Product liability insurance certificates are not acceptable.

h. In the event that the equipment is internally isolated and restrained, the entire unit assembly must be seismically attached to the structure. Curb or roof rail mounted equipment must not only have seismic attachment of the equipment to the roof but also to the curb or rails. The attachment and certification thereof shall be by this section. Sheet metal screw attachment is unacceptable.

i. Failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8 inch and/or horizontal permanent deformation greater than 1/4 inch or failure of the equipment to operate.

1.4 RELATED WORK

A. Housekeeping pad design shall be by the project structural engineer or as shown on the contract drawings. Attachment shall be designed and certified according to this section by the seismic/isolation supplier. Material and labor required for attachment and construction shall be by the concrete section contractor, or by this contractor where specified. Housekeeping pads shall be sized to accommodate a minimum of 6" of clearance all around the equipment or 12 times the anchor bolt diameter, whichever is greater. Where exterior isolators are used this distance shall be as measured from the outboard holes in the isolator base plate and its mounting package.

B. Structural support and connections for all equipment, including roof-mounted equipment, specified in other sections shall comply with all IBC requirements indicating load path to the structure.

C. Roof steel supporting roof-mounted equipment shall be designed for all seismic forces including, but not limited to, tension, compression and moment loads.

D. Where ceilings are not braced (Exclusion "C" – Building Category I and II I*p* = 1.0 *Section 1621.2.5*) lighting fixtures shall have independent 4 corner diagonal wire ties to structure.

E. Lay-in ceilings in compliance with seismic zone requirements may use earthquake clips or otherwise approved means of positive attachment to brace fixtures such as light panels less than 75 pounds to T-bar structures. Local codes dictate support requirements.

1.5 CODE AND STANDARDS REQUIREMENTS

A. Typical Applicable Codes and Standards

1. All City, State and Local Codes (Code)

2. SMACNA Guidelines for Seismic Restraint of Mechanical Systems (to be used as a Standard, not a code)

3. NFPA 13 and 14 for Fire Protection System (Standard)

4. American Society For Testing and Materials (ASTM) (Standard)

5. International Conference of Building Officials (ICBO) (Standard)

6. Internal Building Code (Code)

7. ASHRAE (Standard)

B. In cases where requirements vary, the guideline for the most stringent shall be utilized.

C. Use IBC-2018 as reference code standard unless otherwise designated.

1.6 MANUFACTURER'S RESPONSIBILITY

A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:

1. Determine vibration isolation and seismic restraint sizes and locations.

2. Provide vibration isolation and seismic restraints as scheduled or specified.

3. Provide calculations and materials if required for restraint of unisolated equipment.

4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

5. Certify correctness of installation upon completion.

6. All provisions of Section 1.3, Section "C", Seismic Certification and Analysis

B. All manufacturers, including Original Equipment Manufacturer (OEM), providing equipment and/or vibration/seismic control systems, must provide a Seismic Design Error and Omissions Insurance Certificate for their firm or their design consultant to certify their ability to provide engineering and design as required by this section.

C. All manufacturers of any type of equipment including Original Equipment Manufacturers (OEM) are responsible for Section 1.1.-1.6 including 1.3 Section "C", Seismic Certification and Analysis.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. All vibration isolators and seismic restraints described in this section shall be the product of a single manufacturer. The basis of this specification is Vibration Mountings and Controls. Products from other nationally recognized manufacturers are acceptable provided their systems strictly comply with these specifications and have the approval of the specifying engineer. (See Form VL-1 listing other manufacturers to be considered for use on this project)

2.2 VIBRATION ISOLATION TYPES

A. Type A: Spring Isolator – Free Standing
VMC: ASC

1. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the base plate and the support.

2. All mountings shall have leveling bolts that must be rigidly bolted to the equipment.

3. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load.

4. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

5. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.

B. Type B: Seismically Restrained Spring Isolator
VMC: AWRS, ASCM

1. Restrained spring mountings shall have a Type A spring isolator within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/4" shall be maintained around restraining bolts and internal neoprene deceleration bushings so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces.

C. Type C: Combination Spring/Elastomer Hanger Isolator (30º Type)
VMC: RSH30

1. Hangers shall consist of rigid steel frames containing minimum 1 1/4" thick neoprene elements at the top and a steel spring with general characteristics as in Type A. The neoprene element shall have neoprene bushings projecting through the steel box.

2. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30º arc from side to side before contacting the rod bushing and short circuiting the spring.

3. Submittals shall include a hanger-drawing showing the 30º capabilities.

4. Hanger locations requiring pre-compression for holding piping at fixed elevation shall be type pre-compressed for all manufacturers.

D. Type D: Elastomer Double Deflection Hanger Isolator
VMC: RHD

1. Molded (minimum 1 1/4" thick) neoprene element with projecting busing lining the rod clearance hole. Static deflection at rated load shall be a minimum of 0.35".

2. Steel retainer box encasing neoprene mounting capable of supporting equipment up to four times the rated capacity of the element.

E. Type E: Combination Spring/Elastomer Hanger Isolator
VMC: RSH

1. Spring and neoprene elements in a steel retainer box with the features as described by Type C and D isolators.

2. Hanger locations requiring pre-compression for holding piping at fixed elevation shall be type pre-compressed for all manufacturers.

3. 30º angularity feature is not required.

F. Type F: Seismically Restrained Elastomer Floor Isolator
VMC: RSM

1. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" and all directional seismic capability. The mount shall consist of a ductile iron or aluminum casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications.

G. Type G: Pad Type Elastomer Isolator (Standard)
VMC: Maxiflex

1. One layer of 3/4" thick neoprene pad consisting of 2" square modules for size required.

2. Load distribution plates shall be used as required.

3. Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short-circuiting.

H. Type H: Pad Type Elastomer Isolator (High Density)
VMC: Fabriflex

1. Laminated canvas duck and neoprene, maximum loading 1000 psi, minimum 1/2" thick.

2. Load distribution plate shall be used as required.

3. Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short-circuiting.

I. Type I: Thrust Restraints
VMC: RSHTR

1. A spring element similar to Type A isolator shall be combined with steel angles, backup plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting movement of air handling equipment to 1/4".

2. Restraint shall be easily converted in the field from compression type to tension type.

3. Unit shall be factory precompressed.

4. Thrust restraints shall be installed on all cabinet fan heads, axial or centrifugal fans whose thrust exceeds 10% of unit weight.

J. Type J: Pipe Anchors
VMC: MDPA

1. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" thick 60 durometer neoprene.

2. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction.

3. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction.

K. Type K: Pipe Guides
VMC: PG

1. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of 60-durometer neoprene.

2. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement.

3. Guides shall be capable of +/- 5/8" motion, or to meet location requirements.

L. Type L: Isolated Pipe Hanger System
VMC: CIH, CIR, TIH, PIH

1. Precompressed spring and elastomer isolation hanger combined with pipe support into one assembly. Replaces standard clevis, single or double rod roller, or double rod fixed support.

2. Spring element (same as Type A) with steel lower spring retainer and an upper elastomer retainer cup with an integral bushing to insulate support rod from the isolation hanger.

3. The neoprene element under the loser steel spring retainer shall have an integral bushing to insulate the support rod from the steel spring retainer.

4. Hangers shall be designed and constructed to support loads over three times the rated load without failure.

5. System shall be precompressed to allow for rod insertion and standard leveling.

2.3 SEISMIC RESTRAINT TYPES

A. Type I: Spring Isolator, Restrained
VMC: ASCM, AWR

1. Refer to vibration isolation Type B.

B. Type II: Seismically Restrained Elastomer Floor Isolator
VMC: RSM

1. Refer to vibration isolation Type F.

C. Type III: All-Directional Seismic Snubber
VMC: Type SR:

1. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4 inch thick. Rated loadings shall not exceed 1000 psi. A minimum air gap of 1/8 inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated.

D. Type IV: Floor or Roof Anchorage
VMC: FA

1. Rigid attachment to structure utilizing wedge type anchor bolts, anchored plates machine screw, bolting or welding. Power shots are unacceptable.

E. Type V: Seismic Cable Restraints
VMC: SCR

1. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two (2) and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two (2) clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Single arm braces with resilient bushings can be substituted for seismic cable restraints. Deck fittings shall have two (2) through bolts spaced to ICBO standards for attachment to concrete.

F. Type VI: Rigid Arm Brace
VMC: SAB

1. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of two (2) and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two (2) through bolts to provide proper attachment spaced to ICBO standards for attachment to concrete.

G. Type VII: Internal Clevis Cross Brace
VMC: ICB

1. Internal clevis cross braces at seismic locations shall be pre-cut pipe sized for internal clevis dimensions.

2.4 EQUIPMENT BASES

A. General

1. All curbs and roof rails are to be bolted or welded to the building steel or anchored to the concrete deck (minimum thickness shall be 4") for resisting wind and seismic load forces in accordance with the project location. (Fastening to metal deck is unacceptable.)

B. Base Types

1. Type B-1: Integral Structural Steel Base
VMC: WFB

a. Rectangular bases are preferred for all equipment.

b. All perimeter members shall be steel beams with a minimum depth equal to 1/12 of the longest dimensions of the base.

c. Base depth need not exceed 12" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.

d. Height saving brackets shall be employed in all mounting locations to provide a minimum base clearance of 2".

2. Type B-2: Concrete Inertia Base
VMC: MPF

a. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations.

b. Bases shall be a minimum depth of 1/12 of the longest dimension of the base but not less than 6".

c. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity.

d. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom.

e. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured.

f. Height saving brackets shall be employed in all mounting locations to maintain a 2" minimum clearance below the base.

g. Flush profile wooden formed bases having correct depth and reinforcing requirements are acceptable.

3. Type B-3: Seismic Isolation Curb
VMC: P62/P6300 Sound package type VMC type RPFMA/SRPFMA

a. Curb mounted rooftop equipment shown on isolation schedule shall be mounted on structural seismic spring isolation curbs. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind and seismic forces. The lower frame must accept point support for both seismic attachment and leveling. The upper frame must be designed with positive fastening provisions (welding or bolting), to anchor the roof top unit to the curb, which will not violate the National Roofing Contractor's Association (NRCA) ratings of the membrane waterproofing. Sheetmetal screws are unacceptable. Contact points between the roof top unit, the curb and the building's structure shall show load path through those locations only.

b. All directional neoprene snubber bushings shall be a minimum of 1/4" thick. Steel springs shall be laterally stable and rest on 1/4" thick neoprene acoustical pads.

c. Hardware must be plated and the springs provided with a rust resistant finish.

d. The curbs waterproofing shall be designed to meet all NRCA requirements.

e. All spring locations shall have access ports with removable waterproof covers and all isolators shall be adjustable, removable and interchangeable.

f. The curb shall be the sound attenuating type utilizing standard 2" roof insulation supplied and installed by the roofing contractor to act thermally outside and acoustically inside. Curbs supplied without this feature shall be factory acoustically lined with 2" duct liner.

Option #1: Where sound barrier package is required, curb shall have full size lay in attenuation panels having a minimum STC rating of 60 when combined with the roof deck's rating. Attenuation system shall add a full sound attenuation structural floor to the curb capable of spanning the curb's width and designed for live loads of 20 psf. Panels shall not weigh more than 6 psf. The 4" nominal galvanized panels shall be joined to allow for airtight construction and additionally shall have a support system where the panels are used below an outside condenser section. Panels shall be waterproof for both outdoor and indoor application. The space below the curb panels and the roof deck shall have 4" of insulation contractor furnished and installed.

Curb wall construction shall utilize the roofer's standard insulation where curbs use the TAS open thermal acoustical screening system. Solid wall curbs shall use 2" of factory ductliner installed by the curb manufacturer. The entire curb shall have a continuous neoprene air seal. Type RPFMA shall use an open return system with the roof return opening set as far as possible from the unit's return opening.

Option #2: When curb type SRPFMA (Supply Return Plenum Construction) is required, in addition to Option #1 the walls of the supply section will use 2" sound attenuating panels as well as a continuous inner neoprene air seal and isolated plenum divider. Both supply and return ducts shall seal directly to curb base floor attenuation panels.

4. Type B-4: Seismic Non-Isolated Curbs
VMC: P6000
Sound Package Type – VMC – RPFMA/SRPFMA System

a. These curbs shall have all provisions as Type B-3 curbs with the exception of spring isolation.

5. Type B-5: Isolated Equipment Supports
VMC: R7200/R7300

a. Continuous structural equipment support rails that combine equipment support and isolation mounting into one utilized roof flashed assembly with all features as described for Type B-3.

b. System shall be designed for positive anchorage or welding of equipment to supports and welding of supports to the building steel.

6. Type B-6: Non-Isolated Equipment Supports
VMC: R7000

a. This shall have the same provisions as Type B-5 without the spring isolation.

PART 3 - EXECUTION

3.1 GENERAL

A. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.

B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

D. The contractor shall not install any isolated equipment, or conduit, which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. General bracing may occur from flanges of structural beams, upper truss cords in bar joist construction and cast in place inserts or wedge type drill-in concrete anchors.

G. Seismic cable restraints shall be installed slighting slack to avoid short circuiting the isolated suspended equipment or piping.

H. Seismic cable assemblies are installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems except where single arm braces incorporate resilient bushings.

I. At locations where seismic cable restraints or seismic sold braces are located the support rods must be braced when necessary to accept compressive loads.

J. At all locations where seismic cable braces and seismic cable restraints are attached to the pipe clevis, the clevis bolt must be reinforced with pipe clevis cross bolt braces or double inside nuts if required by seismic acceleration levels.

K. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted.

L. Where piping passes through walls, floors or ceilings, the contractor shall provide wall seals or resilient packed pipe sleeves.

M. Special and Periodic Inspections for items listed in Section 1.3, Article 4 shall be conducted and submitted on a timely basis.

3.2 EQUIPMENT INSTALLATION

A. Equipment shall be isolated and restrained as per Tables A, B and C at the end of this section.

B. Place floor mounted equipment on 4" high concrete housekeeping pads properly doweled or expansion shielded to the deck to meet acceleration criteria (see Section 1.4). Anchor isolators and/or bases to housekeeping pads. Concrete work is specified under Concrete in the specifications of the contract.

C. Additional Requirements

1. The minimum operating clearance under all isolated components bases shall be 2".

2. All bases shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the equipment, isolators and restraints.

3. The equipment shall be installed on blocks to the operative heights of the isolators. After the entire installation is complete, and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. Remove all debris from beneath the equipment and verify that there are no short circuits of the isolation. The equipment shall be free in all directions.

4. Ceilings containing diffusers must meet seismic zone requirements by using earthquake clips or other approved means of positive attachment to secure diffuser to T-bar structure.

5. All floor or wall mounted equipment and tanks shall be restrained with Type IV restraints.

3.3 CONDUIT ISOLATION

A. Riser Location: All risers shall be supported on Type J or K anchors or guide restraints positive attached to both the riser and structure. Spiders welded to the pipe can substitute for Type K guides using Type J anchors.

B. Seismic Restraint of Conduit, and Cable Tray

1. See Table D for maximum seismic bracing distances.

2. Rod braces shall be used for all rod lengths greater than 3'.

3. Clevis hangers shall have spacers placed inside of hanger at seismic brace locations.

4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.

5. Branch lines may not be used to restrain main lines.

EXCLUSIONS

Exclusions for equipment in states governed by BOCA, UBC, IBC.

CONDUIT, CABLE TRAYS & BUS DUCTS (Components)

All conduit less than 2 1/2" diameter suspended by individual hanger rods. All clevis supported pipe or conduit less than 12" from the top of the conduit to the underside of the support point. Trapeze supported cable trays suspended by hanger rods having a distance less than 12" in length from the underside of the tray support to the support point of the structure.

ADDITIONAL EXCLUSIONS for equipment in states governed by UBC: Floor mounted equipment weighting less than 400 lbs. and not resiliently mounted.

EXCLUSIONS

DO NOT apply for LIFE SAFETY or HIGH HAZARD equipment as listed in Section 1.1, C regardless of governing code for Electrical. *(A partial list is illustrated)* High Hazard is additionally classified as any system handling flammable, combustible or toxic material. Typical systems not excluded are additionally listed below.

ELECTRICAL

Critical, standby or emergency power conduit (1" nominal diameter and larger), cable tray or bus duct, lighting, panel, communication lines involving 911, etc.

3.4 INSPECTION

A. All Independent Special and Periodic Inspections must be performed and submitted on components as outlined in Article 1.3, Section 4b.

B. Upon completion of installation of all vibration isolation devices, the local representative shall inspect the completed project and certify in writing to the contractor that all systems are installed properly, or require correction. The contractor shall submit a report to the Architect,

including the representative's report, certifying correctness of the installation or detailing corrective work to be done.

Note for TABLES C and D:

GENERAL: ISOL = ISOLATOR, DEFL = DEFLECTION, RESTR = SEISMIC RESTAINT, MTNG = MOUNTING. ALL DEFLECTIONS INDICATED ARE IN INCHES.

Note 1: For equipment with variable speed driven components having driven operating speed below 600 rpm, select isolation deflection from minimum deflection guide.

Note 2: For roof applications, use base Type B-5.

Note 3: Curb Type B-3 shall use sound barrier RPFMA when there is no concrete under rooftop units. Curbs can be used for return plenums. (See Option #1)

Note 4: Where curbs require supply and return sound attenuation package type SRRFMA shall be used. (See Option #2)

(Engineers' Note: Where Type 3 or 4 sound attenuation systems are used this note shall appear on equipment schedule.)

Note 5: Units may not be capable of point support. Refer to separate air handling unit specification section. If base is not provided by that section and external isolation is required, provide Type B-1 base by this section for entire unit.

Note 6: Static deflection shall be determined based on the deflection guide for Table "A".

Note 7: Deflection indicated are minimums at actual load and shall be selected for manufacturer's nominal 5", 4", 3", 2" and 1" deflection spring series, RPM is defined as the lowest operating speed of the equipment.

Note 8: Single stroke compressors may require inertia bases with thickness greater than 14" maximum as described for base B-2. Inertia base mass shall be sufficient to maintain double amplitude for 1/8".

Note 9: Indoor utility sets with wheel diameters less than 24" need not have deflections greater than .75".

Note 11: For equipment with multiple motors, Horse Power classification applies to largest single motor.

ON GRADE, BASE OR
SLAB ON GRADE ABOVE GRADE

TABLE C
VIBRATION ISOLATION & SEISMIC RESTRAINT
REQUIREMENTS FOR ELECTRICAL EQUIPMENT
INSTALLATION ATTACHMENT POINT

	ON GRADE	ABOVE GRADE

EQUIPMENT	SIZE	MTNG	ISO	DEFL	BASE	RESTR	ISOL	DEFL	BASE	RESTR
TRANSFORMER Dry Type	ALL	Flr	--	--	--	IV	D	0.30	*	IV
		CEILING	--	--	--	V	E	0.20	*	V
GENERATORS	ALL	Flr	B	1.0	--	IV	B	1.50	*	IV
GENERATORS	ALL	Over Occupied Space					B	2.50	*	IV
UPS SYSTEMS	M		II	.40		IV	B	1.50	*	IV

***** *Where component cannot be point supported base type B-1 shall be used.*

TABLE D
SEISMIC BRACING TABLE
(Maximum Spacing Shown – Actual Spacing to Be Determined by Calculation)

EQUIPMENT	ON CENTER TRANSVERSE	ON CENTER LONGITUDINAL	CHANGE OF DIRECTION
PIPE THREADED, WELDED, SOLDERED OR GROOVED			
PIPE – NO HUB OR BELL AND SPIGOT			
CONDUIT	40 FEET	80 FEET	4 FEET
CABLE TRAY	40 FEET	80 FEET	4 FEET

FORM CQAP

Section 26 05 48
Vibration Isolation and Seismic Restraints

Contractor Name: _____

Date: _____

Project: _____

Specification Section: _____

Contractor IBC Quality Assurance Seismic Program (Part of SGMEC) Specification

This form is to be filled out before the first submission in any vendor group by the installing contractor. All items listed herein shall be part of the contractor's quality assurance program.

1. Acknowledge special requirements contained in the quality assurance plan.
2. Acknowledge that control will be exercised to obtain conformance with the construction documents.
3. Procedures for exercising control within the contractor organization including frequency and distributions of inspections and testing reports.
4. Identification and qualification of the persons exercising control of this program within their organization.

Contractor to submit this program acknowledging receipt and program implementation. Each of the 4 (four) listed programs are to be submitted including all applicable details as listed above.

_____
Signature

_____
Print Name

FORM CVC-1

Section 26 05 48
Vibration Isolation and Seismic Restraints

Contractor Name: _____

Date: _____

Project: _____

Specification Section: _____

Notes to the Installing Contractor

The purpose of this form is for you the contractor to fill in all vendors that are IBC approved as part of your initial submission for any group of equipment, i.e., fans, ac units, pumps, etc. By identifying which of the vendors have IBC approval, both you and the project's specifying engineer are protected. Only IBC approved vendors can participate on this project. In the event that no vendor in any group has IBC certification then any vendor who meets the project's performance specifications is acceptable.

Note: The cutoff date for this requirement, for any vendor group, is the project's plan filing date for Code Review on this project.

MANUFACTURER	YES	NO

_____
Signature

_____
Print Name

FIRN SQA-1

Section 26 05 48
Vibration Isolation and Seismic Restraints
Seismic Quality Assurance Plan for the Installation of Life Safety
And High Hazard Systems (Inspections)

Contractor Name: _____

Date: _____

Project: _____

Specification Section: _____

The following are required for the Seismic Quality Assurance Installation Plan for Life Safety and High Hazard Systems to be prepared and submitted by each installing contractor. This plan must reflect all of the provisions and reports outlined in the paragraphs below. As part of this contractor's final requisition, this form must accompany, along with all satisfactorily completed tests and reports, the final payments request including all applicable certification reports.

- Special field inspection and testing is required by IBC Sections 1704, 1707 and 1708 during the installation of Life Safety and High Hazard System components including equipment, piping and all electrical connections. Components must be inspected by a Building Official or approved independent special inspector periodically during the course of installation. Contractor shall submit such inspection reports as part of his project wrap up for each group of equipment, components so requiring this program. All components, which are Life Safety, designate or Handle Hazardous substances, fall into this category. Typical Life Safety and High Hazard components as well as non-life safety components listed in that section are outlined in Section 4 of the SGMEC® Specifications.

_____
Signature

_____
Print Name

END OF SECTION 26 05 48

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide fixed identification of all distribution equipment and conductors in accordance with the Contract Documents.

B. Related work in other sections:

1. Section 26 05 21 – Wires and Cables
2. Section 26 24 16 – Panelboards
3. Section 26 28 23 – Disconnect Switches – Fused and Non-Fused
4. Section 26 29 13 – Enclosed Controllers
5. Section 26 36 23 and Section 26 36 24 – Automatic Transfer Switches
6. Section 26 51 00 – Interior Lighting
7. Section 28 31 02 – Multiplex Fire Alarm System

1.2 REFERENCES

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Industry standards shall apply.

1.3 SUBMITTALS

A. Identification procedures shall be noted and scheduled on the applicable shop drawings.

PART 2 - PRODUCTS

2.1 Unless otherwise noted, nameplates shall be black lamacoid plates with white engraved upper case letters enclosed by white border on beveled edge.

2.2 Nameplates for equipment, supplied by the emergency system, shall be red lamacoid with white lettering.

2.3 All nameplates must be engraved and must be secured with rivets, brass or cadmium plate screws. The use of Dymo tape or the like is unacceptable.

2.4 Lettering heights unless otherwise noted must be as follows:

Item	Lettering Height
Switchboards and Unit Substations and Primary Switchgear	2"
Motor Control Centers	2"
Panelboards and Load Centers	1/2"
Multiple Meter Centers	1/2"
Bus Ducts	1/2"
Feeder Switches	1/4"
Remote Smoke Detector Lamps	1/8"
Wall Plates	1/8"
Motor Controllers	1/4"
Fire Alarm Terminal Cabinets	1/2"
Automatic Transfer Switches	1/2"
Generator Control Cabinets	1"

2.5 Cable tags must be flameproof secured with flameproof non-metallic cord.

2.6 Nameplate inscriptions must bear the name and number of equipment to which they are attached as indicated on the Drawings. The engineer reserves the right to make modifications in the inscriptions as necessary.

2.7 The Engineer reserves the right to request additional nameplates at time of review of shop drawings and upon site observations. These shall be furnished at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Panelboards and Load Centers

1. Furnish and install a nameplate for each panelboard and load center engraved with the identification indicated on the Drawings. Mount at top of panel.

2. After installations are complete, provide and mount under sturdy transparent shield in the directory frame of each panel door, a neat, accurate, and carefully typed directory properly identifying the lighting, receptacles, outlets and equipment each overcurrent device controls.

3. Include on directory the panel or load center identification, the cable and raceway size of panel feeder, and the feeder origination point.

B. Disconnect Switches

1. Furnish and install a nameplate for each disconnect switch engraved with the equipment designation which the disconnect serves.

C. Motor Controllers

1. Furnish and install a nameplate for each motor controller or combination motor controller for both individual motor controllers and those in a motor control center, etc. Engraving must indicate the motor served and the type of service (e.g., AC-8 – 1st floor supply, EF-2 electric closet exhaust).

D. Remote Smoke Detector Lamps and Test Stations

1. Furnish and install a nameplate on each remote smoke detector lamp and/or test station. Engraving must indicate the location of the devise to which the lamp is connected, as approved by the Engineer.

E. Switches

1. Furnish and install an engraved nameplate for each switch, controlling loads which are not local to the switch. Engraving shall be as directed by the Engineer.

F. Pullboxes, Enclosures and Cable Terminations

1. Furnish and install cable tags on each cable, which enters a pullbox, enclosure, switchboard, and at terminations. Mark tags with type written inscription noting the load served, type and size of cable, and the overcurrent device protecting the cable.

G. Fire Alarm Phone Jacks and Wardens Stations

1. Furnish and install a nameplate on each warden's station and portable fire alarm phone jack. Engraving must indicate the floor and location of the station.

H. Freeze Protection

1. Install decal type labels on each pipe, which is provided with, freeze protection.
2. Labels shall be inscribed "CAUTION-ELECTRIC HEAT TRACING."
3. Affix labels to the thermal insulation not more than 20'-0" on center but not less than every length of pipe.

I. Fire Alarm Terminal Cabinets

1. Furnish and install on each fire alarm terminal cabinet an approved nameplate.

2. Nameplates shall indicate floor and where multiple terminal cabinets are installed a prime designation for each cabinet (e.g. FATC-1A, FATC-1B).

3. Terminal shall be permanently identified in an approved manner.

J. Luminaires

1. Where connected to other than 120-volt circuit, provide each fluorescent or high intensity discharge fixture with the ballast voltage stenciled on the ballast cover in letters not less than 1/2 inch high.

K. Telecommunications System

1. Each cable from a patch panel to a data transmission system outlet shall have a flameproof tag attached at both ends of the tag. Tags shall be consecutively numbered so that no two (2) cables have the same identification. In addition cable tag shall note the room number in which the data transmission outlet is located.

2. Each cable from a patch panel to the head end equipment shall have a flameproof tag attached at both ends of the tag. Tags shall be consecutively numbered so that no two (2) cables have the same identification. Additional inscriptions shall be provided as directed by the Owner.

3. Patch panel outlets shall be consecutively numbered so that no two (2) ports have the same number, unless they are in the out ports having the same numbers.

L. Painting and Finishing

1. All electrical fitting, supports, hanger rods, pullboxes, channel frames, conduit racks, outlet boxes, brackets clamps, etc., shall be galvanized finished or have enamel paint finish over corrosion-resistant primer.

2. All panelboards, distribution centers, motor control centers, transformers, etc., shall be factory finished in alkyd high gloss enamel applied over corrosion-resistant primer. Matte or flat type-finish paint not acceptable. Factory finished units that are scratched or marked during installation shipping shall be touched up with matching spray-on air dry lacquer or, if required, to provide a satisfactory job, shall be completely refinished.

3. Fire alarm pullboxes and junction boxes to be finished in red.

4. Telecommunications terminal panel and junction boxes to be finished in yellow.

5. Public address terminal panel and junction boxes to be finished in yellow.

6. Intercommunication system terminal panels and junction boxes to be finished in brown.

7. Clock and timing terminal panels and junction boxes to be finished in green.

8. Television system pullboxes and junction boxes to be finished in ivory.

9. Low voltage switching terminal cabinets and pullboxes to be finished in black.

10. Security terminal panel and junction boxes to be finished in yellow.

END OF SECTION 26 05 53

SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices.

1. The "Fault Current and Coordination Study" shall be provided by the manufacturer of the main switchboard(s).

2. The "Fault Current and Coordination Study" shall include all new equipment that is to be installed in the new main service room, emergency generator room and the existing normal service room.

3. Coordination with the utility company shall be included.

4. Emergency system shall be selectively coordinated in accordance with NEC. All new breakers and/or adjustments required to meet the selective coordination requirement as set forth in the NEC shall be included in this project.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals:

1. Coordination-study input data, including completed computer program input data sheets.
2. Coordination-study report.
3. Equipment evaluation report.
4. Setting report.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

C. Testing Agency Qualifications: Member company of the InterNational Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise testing specified in Part 3.

D. Comply with IEEE 399 for general study procedures.

1. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following:

1. CYME International, Inc.
2. EDSA Micro Corporation.
3. Electrical Systems Analysis, Inc.
4. SKM Systems Analysis, Inc.
5. Approved equal.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.

c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Where required, coordinate main devices with Utility Company devices.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

3.2 FAULT-CURRENT STUDY

A. Source Impedance: Obtain available faults from the Utility Company before proceeding with study.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
2. Low-Voltage Fuses: IEEE C37.46.
3. Circuit Breakers: IEEE C37.13.

E. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

F. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.3 COORDINATION STUDY

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Impedance of utility service entrance.

3. Electrical distribution system diagram showing the following:

    a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.

    b. Circuit-breaker and fuse-current ratings and types.

    c. Relays and associated power and current transformer ratings and ratios.

    d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.

    e. Generator kilovolt amperes, size, voltage, and source impedance.

    f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.

    g. Busway ampacity and impedance.

    h. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.

    b. Magnetic inrush current overload capabilities of transformers.

    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

    d. Ratings, types, and settings of utility company's overcurrent protective devices.

    e. Special overcurrent protective device settings or types stipulated by utility company.

    f. Time-current-characteristic curves of devices indicated to be coordinated.

    g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

C. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

D. Comply with IEEE 242 recommendations for fault currents and time intervals.

E. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

F. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.

b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.

c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.

d. Fuse-current rating and type.

e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:

   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

3. Completed data sheets for setting of overcurrent protective devices.

3.4 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.

B. Testing: Perform the following device setting and prepare reports:

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:

   a. Verify that overcurrent protective devices meet parameters used in studies.
   b. Adjust devices to values listed in study results.

2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.

END OF SECTION 26 05 73

SECTION 26 05 83 - ARC FLASH HAZARD STUDY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide an Arc Flash Hazard Study for the electrical distribution system shown on the one line drawings. The intent of the Arc Flash Hazard Study is to determine hazards that exist at each major piece of electrical equipment shown on the one line drawing. This includes switchgear, switchboards, panelboards, motor control centers, PDUs, UPS, ATSs, and transformers. The study will include creation of Arc Flash Hazard Warning Labels. These labels serve as a guide to assist technicians and others in the selection of proper Personal Protective Equipment when working around exposed and energized conductors. The electrical contractor will install the labels.

Example of Arc Flash Warning Label

B. The arc flash hazard study shall include the electrical distribution system equipment shown on the one line drawing. If an existing up-to-date current short-circuit and protective device coordination study is not available, perform a short circuit and protective device coordination study for the electrical distribution system before performing the Arc Flash Hazard Study. The arc flash hazard study shall consider operation during normal conditions alternate operations, emergency power conditions, and any other operations, which could result in maximum arc flash hazard.

1.2 QUALIFICATIONS

A. The Contractor shall have the study prepared by qualified engineers of an independent consultant. The consultant shall be a Registered Professional Electrical Engineer (licensed in the state where the project is completed) who has at least ten (10) years of experience and specializes in performing power system studies.

B. The arc flash hazard study shall be performed using SKM PowerTools for Windows computer software packages. No substitutions.

C. Pre-approved: Power Systems Engineering, P.S. - Covington, WA.

1.3 SUBMITTALS

A. The contractor shall submit the arc flash hazard study and arc flash warning labels at least 30 days prior to energizing the electrical equipment.

B. Submit three (3) copies of the power systems study and (1) set of warning labels.

PART 2 - EXECUTION

2.1 SHORT CIRCUIT STUDY

A. Provide a current up-to-date short circuit study. If one does not exist, then perform a short circuit study as specified in Section 26 05 73.

2.2 PROTECTIVE DEVICE COORDINATION STUDY

A. Provide a current up-to-date protective device coordination study. If one does not exist, then perform a protective device coordination study as specified Section 26 05 73.

2.3 ARC FLASH HAZARD STUDY

A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed.

B. The study shall be calculated by means of the SKM PowerTools for Windows computer software package. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.

C. The study shall be in accordance with applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub part S and IEEE 1584 Standards.

D. Determine the following

1. Flash Hazard Protection Boundary
2. Limited Approach Boundary

3. Restricted Boundary
4. Prohibited Boundary
5. Incident Energy Level
6. Required Personal Protective Equipment Class
7. Type of Fire Rated Clothing

E. Produce an Arc Flash Warning label listing items 1 – 7 above. Also include the bus name and voltage. Labels shall be printed in color and be printed on adhesive backed Avery Labels. See example above.

F. Produce Bus Detail sheets that lists the items D 1 – 7 from above and the following additional items:

1. Bus Name
2. Upstream Protective Device Name, Type, and Settings
3. Bus Line to Line Voltage

G. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:

1. Bus Name
2. Upstream Protective Device Name, Type, and Settings
3. Bus Line to Line Voltage
4. Bus Bolted Fault
5. Protective Device Bolted Fault Current
6. Arcing Fault Current
7. Protective Device Trip / Delay Time
8. Breaker Opening Time
9. Solidly Grounded Column
10. Equipment Type
11. Gap
12. Arc Flash Boundary
13. Working Distance
14. Incident Energy
15. Required Protective Fire Rated Clothing Type and Class

PART 3 - ANALYSIS

3.1 Analyze the short circuit, protective device coordination, and arc flash calculations and highlight any equipment that is determined to be underrated or causes an abnormally high incident energy calculation. Propose approaches to reduce the energy levels. Proposed major corrective modifications will be taken under advisement by the Engineer, and the Contractor will be given further instructions.

PART 4 - REPORT

4.1 The results of the power system study shall be summarized in a final report. The report shall include the following sections:

A. Introduction, executive summary and recommendations, assumptions, reduced copy of the one line drawing.

B. Arc Flash Evaluations Summary Spreadsheet

C. Bus Detail Sheets

D. Arc Flash Hazard Warning Labels printed in color on adhesive backed labels.

END OF SECTION 26 05 83

SECTION 26 07 00 - ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 GENERAL

A. The work of this section includes furnishing of all labor, tools, materials, and equipment necessary to complete all the demolition required for the project as specified herein and shown on the drawings.

B. Cooperation with contractors under separate contracts is required, and the work described herein and shown on the drawings shall be coordinated as required to fulfill the intent of the contract.

1.2 INTENT

A. It is the intent of this specification and accompanying drawings to describe and indicate the demolition work to be performed. It is not intended that the specifications and drawings describe and indicate every piece of equipment required to be removed for where items are intended to be removed or as required for the satisfactory completion of the project or is considered to be the accepted practice of the trade, they shall be considered to be specified and indicated.

B. The contractor shall disconnect and remove all lighting fixtures, conduit, wire and related electrical items as indicated on the drawings, or as required by the project. This includes all abandoned low voltage signal and communication cables.

C. The contractor shall seal floor, wall and ceiling openings with thermo setting fire resistive compound after removal of conduits.

D. The contractor is cautioned that when performing demolition work circuitry servicing areas of the building outside the work area must remain in operation. The contractor is responsible, at his own expense, to repair any services or damages caused by his demolition work.

E. When disconnecting equipment from existing circuits, if equipment is connected to the circuit which must remain active, the circuit continuity shall be maintained as required. Wiring from circuits becoming completely inactive shall be removed back to the source of supply.

PART 2 - SCOPE OF WORK

2.1 DEMOLITION/ALTERATION

A. Prior to start of demolition, check to determine that power, communication services, etc., such as electricity and telephone, have been disconnected at the source of supply.

B. The Contractor shall furnish and erect barriers, and maintain approved danger, warning, and "Keep Out" signs at locations where the placing of such signs is warranted for safety of all personnel not working in this area.

C. Demolition shall be performed in such a manner as to avoid hazards to persons and property, interference with the use of adjacent properties, and interruption of free passage to and from such property. Work shall be performed in strict accordance with all Municipal, State and Federal Rules, Regulations, Codes, and Laws which may govern and apply to this work.

D. During the demolition work in the effected areas, the building non-work areas must be protected from dust, dirt and possible water damage, to the Owner's satisfaction.

E. All areas shall be cleaned and free of all debris resulting from the demolition work on a daily basis.

F. Remove all equipment shown to be removed; however, all changes cannot be detailed completely on the drawings, some removals and relocations of existing electric work will be necessary for satisfactory performance of this and other trades. Take into consideration in proposal all required changes.

G. Maintain continuous service on feeders, circuits or partial circuits, and outlets affected by this work, except where Architect gives written permission for outage for specified time. All work requiring shut down of existing systems shall be performed on overtime at hours as approved by the Architect and at no additional cost to the Owner. Submit schedule of required outages to the Owner for approval. Perform work in a manner to minimize shutdown time.

H. Provide reconnections and temporary installations as required; remove at job completion.

I. Take possession and remove from the premises all abandoned materials and equipment unless specified as returnable to the Owner; in which case, remove without damage all such equipment and turn over and deliver to Owner at location designated by the Owner.

J. Cut back to floor, wall, or ceiling and plug ends of concealed conduits made obsolete by alterations to permit refinishing surfaces. Remove exposed conduits, wireways, outlet boxes, hangers and devices made obsolete by this work unless designated specifically to remain.

K. Existing concealed conduits not interfering with the work of this or any other trade may remain; however, wiring shall be removed from panelboards or source of power and ends taped. No unused live wiring shall be left in place.

L. Provide blank plates on all unused outlet boxes.

M. Wherever extensions of wires or cables are shown on the drawings, check and verify wire and cable sizes and capacities. Secure Architect's acceptance of this data before new cables are ordered or installation started.

N. Some equipment is required to be disconnected, removed and stored until renovation is complete. This equipment shall then be reinstalled and re-connected. Coordinate with construction manager.

PART 3 - SALVAGE

3.1 SALVAGE

A. The contractor shall be responsible for all damage to existing materials not affected by the demolition work. The contractor shall repair or replace damaged material or equipment as directed at no additional cost to the owner. Repairing and patching of areas shall be done by the respective trade involved with the demolition, utilizing workmen skilled in the trade involved with the repair or replacement of the material in question.

B. All equipment, removed during demolition shall remain on the site, unless otherwise noted. The Owner reserves all rights to claiming material removed during demolition. The contractor is responsible to remove from the site all material not claimed by the Owner. In addition, the contractor is responsible to deliver to the Owner's storage facilities, equipment claimed by the Owner.

END OF SECTION 26 07 00

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Outdoor photoelectric switches.
3. Switch-box occupancy sensors.
4. Indoor occupancy sensors.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Lighting plan showing location, orientation, and coverage area of each sensor.
2. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.3 TIME SWITCHES

A. Available Manufacturers:

1. Intermatic, Inc.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting.
4. Paragon Electric Co.
5. TORK.
6. Watt Stopper (The).
7. Or approved equal.

B. Digital Time Switches: Electronic, solid-state programmable units with alphanumeric display complying with UL 917.

1. Contact Configuration: As indicated.

2. Contact Rating: 20-A ballast load, 120/240/277 V ac.

3. Program: Single channel, 2 on-off set points on a 24-hour schedule with skip-a-day weekly schedule and an annual holiday schedule that overrides the weekly operation on holidays.

4. Programs: Two channels.

   a. For each channel, 2 on-off set points on a 24-hour schedule with skip-a-day weekly schedule.

   b. For each channel, 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.

5. Circuitry: Allow connection of a photoelectric relay as substitute for on and off function of a program on selected channels.

6. Astronomical Time: Selected channels.

7. Battery Backup: For schedules and time clock.

2.4 SWITCH-BOX OCCUPANCY SENSORS

A. Available Manufacturers:

1. Leviton Mfg. Company Inc.
2. Lithonia Lighting.
3. TORK.
4. Watt Stopper (The).
5. Or approved equal.

B. Description: PIR type with integral power-switching contacts rated for 800 W at 120-V ac, suitable for incandescent light fixtures, LED light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/6-hp motors; and rated for 1000 W at 277-V ac, suitable for incandescent light fixtures, LED light fixtures, fluorescent light fixtures with magnetic or electronic ballasts, or 1/3-hp motors, minimum.

1. Include ground wire.
2. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keeps lighting off when selected lighting level is present.

2.5 INDOOR OCCUPANCY SENSORS

A. Available Manufacturers:

1. Leviton Mfg. Company Inc.
2. Lithonia Lighting.
3. TORK.
4. Watt Stopper (The).
5. Or approved equal.

B. General Description: Ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

4. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outlet box.

b. Relay: Externally mounted though a 1/2-inch knockout in a standard electrical enclosure.

c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

6. Bypass Switch: Override the on function in case of sensor failure.

7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keeps lighting off when selected lighting level is present.

C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of at least 36 sq. in.

2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.

2.6 MULTIPOLE CONTACTORS

A. Available Manufacturers:

1. ASCO Power Technologies, LP; a division of Emerson Electric Co.
2. GE Industrial Systems; Total Lighting Control.
3. Hubbell Lighting Inc.
4. Lithonia Lighting.

5. TORK.
6. Watt Stopper (The).
7. Or approved equal.

B. Description: Electrically operated and mechanically held, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).

2. Control-Coil Voltage: Match control power source.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Division 26 Section "Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG, complying with Division 26 Section "Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 14 AWG, complying with Division 26 Section "Conductors and Cables."

D. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Division 26 Section "Voice and Data Communication Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Conductors and Cables." Minimum conduit size shall be 3/4 inch.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification."

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Verify actuation of each sensor and adjust time delays.

B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within one month of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to one visit to site outside normal occupancy hours for this purpose.

END OF SECTION 26 09 23

SECTION 26 09 34 - INDIVIDUAL DIMMER SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide individual dimmer switches in accordance with the Contract Documents.

B. Related Work Specified in Division 26

1. Section 26 05 33 – Raceways and Boxes
2. Section 26 51 00 – Interior Lighting

C. Related Work Specified in Other Divisions of These Specifications:

1. Finish Painting

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. U.L.

1.3 SUBMITTALS

A. Submit manufacturer's catalog cuts and specifications for dimmers and cover plates.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Lutron

B. Hunt

C. Leviton

2.2 Dimmers shall be of appropriate application for control and dimming of LED, incandescent or quartz luminaires, low voltage luminaires and fluorescent luminaires.

2.3 Each dimmer shall be capable of being ganged with other dimmers without breaking off fins or derating.

2.4 Each dimmer shall employ square law dimming control and shall be voltage stabilized.

2.5 Dimmers shall employ calibrated linear slide control.

2.6 All dimmers shall be equipped with field adjustable maximum lighting level feature which shall have a minimum setting of 50%.

2.7 Dimmers shall be selected for 120 volt and/or 277 volt application and shall be coordinated as to ballast type and quantity of lamps.

2.8 Faceplates shall be white, black, brown, beige or gray as selected by the Architect. Devices serving emergency lighting shall be “RED” in color.

2.9 Where dimmers are employed in series with single pole, 3 way and 4 way switches supply matching companion switches.

PART 3 - EXECUTION

3.1 Mount dimmers vertically with the "on" position on top, unless noted or specified otherwise.

3.2 Where dimmers are indicated to be installed near doors, corner walls, etc., mount same not less than 2 inches and not more than 12 inches from trim. Verify exact location with the Architect.

1. Carefully coordinate the location of dimmers to insure locations at the strike side of doors

2. Furnish and install an engraved legend for each dimmer that controls illumination sources not located within sight of the controlling dimmer.

END OF SECTION 26 09 34

SECTION 26 12 17 - DRY TYPE TRANSFORMERS UP TO 600V PRIMARY

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide dry type transformers in accordance with the Contract Documents.

B. Related Work Specified in Division 26

1. Section 26 05 26 – Grounding and Bonding
2. Section 26 05 29 – Hangers and Supports for Electrical Systems
3. Section 26 05 38 – Raceways and Boxes
4. Section 26 05 53 – Wires and Cables

C. Related Work Specified in Other Divisions of These Specifications

1. Finish painting
2. Concrete

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. U.L. Standard UL-506
2. ANSI C57.12.00 and C89.1
3. NEMA ST 20 and TR 27
4. DOE 10 CFR Part 431

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings and manufacturer's data for each type and size dry transformer as indicated on the Drawings.

1.4 QUALITY ASSURANCE

All transformers shall be of the quiet type, operating at sound levels substantially below ANSI standards as follows:

Size in KVA	Specification	ANSI Standard
0-5	33	40
6-9	37	40
10-25	40	45
26-50	45	45
51-150	45	50

151-225	45	55
226-300	48	55
301-500	55	60

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. All transformers shall be of the same manufacturer as the switchboards.

2.2 DRY TYPE TRANSFORMERS IN GENERAL

A. Transformers shall be 115 degrees C temperature rise above 40 degrees C ambient. Transformers shall be capable of carrying a 15% continuous overload without exceeding a 150 degrees C rise in a 40 degrees C ambient.

B. All insulating materials shall be suitable for 220 degrees C UL component recognized insulation system.

C. Coils: Coil conductors to be continuous with terminations welded without auxiliary flux material. Wind coils with aluminum magnet wire, vacuum impregnated with non-hydroscopic, thermosetting varnish. Coils shall be protected with an outer layer of glass tape or similar quality insulation. Provide each layer with end-fillers or tie-downs to ensure maximum mechanical strength. Brace tap terminations to magnet wire. Brace primary and secondary magnet wire directly to bus studs or lugs. Windings shall be continuous with no splices.

D. Core

1. Manufacture core from a high-grade, non-aging 29 gauge silicon steel with high magnetic permeabilities, low hysteresis and eddy current losses. Keep magnetic flux densities well below saturation to allow for a minimum of 10 percent over voltage excitation.

2. Cut laminations with the direction of the grain and free from burrs. All laminations must be core plated or annealed and firmly butted. The core laminations shall be clamped tightly and compressed to provide quiet operation and to prevent damage during shipment or rough handling.

E. Taps: Provide NEMA Standard taps, 6 – 2 1/2% taps, 2 above and 4 below normal voltage.

F. Enclosures

1. Provide lifting brackets on all sizes.
2. Ventilated openings shall be such as to avoid accidental access to live parts.
3. Degrease, clean, phosphatize and paint the entire enclosure with one (1) coat of zinc chromate primer and two (2) coats of gray enamel.

G. The core and coil assembly shall be grounded to the enclosure by means of a flexible copper grounding strap of adequate size.

H. Mounting

1. Provide transformer up to and including 112-1/2 KVA suitable for floor, wall or ceiling mounting.

I. Vibration Isolation

1. Core and coil assemblies 30 KVA and larger shall be mounted on rubber vibration isolators designed specifically to reduce 120 Hz sound and multiple harmonics.

J. Transformer shall meet the minimum efficiency standards outlined in DOE CFR Part 431.

PART 3 - EXECUTION

3.1 GENERAL

A. Where indicated or as otherwise required and/or approved, resiliently suspend each dry type transformer on double deflection neoprene in the shear hanger rod isolator assemblies, capable of providing minimum 3/8 inch static deflection.

B. Where transformers are to be floor mounted install on 4” high concrete housekeeping pads. Provide neoprene pads between transformer stand and housekeeping pad.

C. Provide grounding conductor from transformer secondary to nearest building ground for each separately derived system. Grounding electrode conductor shall be sized in accordance with NEC Section 250-30 for the separately derived AC system.

D. Flexible conduit shall be used for all conduit connections to transformers; provide external bonding wire.

E. Adjust transformer taps for rated output voltage under normal operating conditions.

END OF SECTION 26 12 17

SECTION 26 13 23 - PAD MOUNTED SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes Pad Mounted Medium Voltage Switches. Switch shall be S&C Source Transfer PMH Pad-mounted switch or approved equal.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of switch indicated.

B. Shop Drawings: Diagram power wiring.

C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Underground primary and secondary conduit location.

2. Dimensioned outline of vault, switch and required clearances.

3. Ground rod and grounding cable locations.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

4. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

5. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For testing agency.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Follow-up service reports.

H. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of switches and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C2.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store switches so condensation will not form on or in units. Provide temporary heating according to manufacturers written instructions.

1.7 PROJECT CONDITIONS

A. Service Conditions: IEEE C37.121, usual service conditions.

1.8 COORDINATION

A. Coordinate size and location of vaults. Cast anchor-bolt inserts into vault tops. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 GENERAL

A. The pad-mounted gear shall be in accordance with the one-line diagram and shall conform to the following specification.

B. The pad-mounted gear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, all completely factory assembled and operationally checked.

C. Ratings

1. The ratings for the integrated pad-mounted gear assembly shall be as designated below.

Kv, Nominal	14.4
Kv, Maximum	17.0
Kv, BIL	95.0
Main Bus Continuous, Amperes	600.0
Three-Pole Interrupter Switches Continuous, Amperes	600.0
Load Dropping, Amperes	600.0
Two-Time Duty-Cycle Fault-Closing, Amperes Rms Asymmetrical	22,400.0
Fuses with Integral Load Interrupter Maximum, Amperes	400.0
Load Dropping, Amperes	400.0
Two-Time Duty-Cycle Fault-Closing Capability, Amperes Rms Asymmetrical	13,000.0
Short-Circuit Ratings Amperes Rms Symmetrical	14,000.0
Mva Three-Phase Symmetrical at Rated Nominal Voltage	350.0

2. The momentary and two-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses, and one-time duty-cycle fault-closing capabilities of fuses with integral load interrupters shall equal or exceed the short-circuit ratings of the pad-mounted gear.

D. Certification of Ratings

1. The manufacturer of the pad-mounted gear shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated assembly as rated.

2. The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure.

E. Compliance with Standards and Codes

The pad-mounted gear shall conform to or exceed the applicable requirements of the following:

Standards and Codes:

1. All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.

2. The National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.

3. All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

F. Enclosure Design

1. To ensure a completely coordinated design, the pad-mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.

2. In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, and corrosion resistance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work included, but are not limited to the following:

1. S&C Electric
2. Schneider Electric (Square D)
3. Cooper Power Systems
4. Or Approved Equal

2.2 INSULATORS

A. The interrupter-switch and fuse-mounting insulator shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

1. Operating experience of at least 15 years under similar conditions.

2. Adequate leakage distance established by test per IEC Publication 507, First Edition, 1975.

3. Adequate strength for short-circuit stress established by test.

4. Conformance with applicable ANSI standards.

5. Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

2.3 HIGH-VOLTAGE BUS

A. Bus and interconnections shall consist of aluminum bar of 56% IACS conductivity.

B. Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted gear.

C. Bolted aluminum to aluminum connections shall be made with a suitable number of 1/2" – 13" galvanized steel bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut. Bolts shall be tightened to 50 foot pounds torque.

D. Before installation of the bus, all electrical contact surfaces shall first be prepared by machine abrading to remove any aluminum oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

2.4 GROUND-CONNECTION PADS

A. A ground-connection pad shall be provided in each compartment of the pad-mounted gear.

B. The ground-connection pad shall be constructed of 3/8" thick steel, which shall be nickel plated and welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.

C. Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

2.5 ENCLOSURE

A. The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion. Enclosure shall have provisions for cable entrance and exit through bottom.

B. The basic material shall be 11-gauge hot-rolled, pickled and oiled steel sheet.

C. All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. The gas-metal-arc welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.

D. To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.

E. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.

F. The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.

G. Enclosure top side edges shall overlap with roof side edges to create a mechanical maze, which shall allow ventilation to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.

H. A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to minimize condensation of moisture thereon.

I. Insulating interphase and end barriers of NEMA GPO3-grade fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of fuses where required to achieve BIL ratings. Additional insulating barriers of the same material shall separate the front compartments from the rear compartments and isolate the tie bus (where furnished).

J. Full-length steel barriers shall separate side-by-side compartments.

K. Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gap when the switch is open. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

L. Interrupter switches shall be provided with window panels to allow viewing of the switch position without removing the dual-purpose front barriers. Window panels shall be removable to facilitate phasing and shall be secured to the enclosure with stainless steel or zinc-nickel-plated hardware.

M. Each fuse shall be provided with a dual-purpose front barrier. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gaps when the fuses are in the disconnect position. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

N. The enclosure shall be provided with an instruction manual holder.

O. Lifting tabs shall be removable. Sockets for the lifting-tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be closed-cell to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

P. Inner barrier panels that meet the Rural Electrification Association's requirements for "dead-front" and the requirements of Section 381G of the national Electrical Safety Code (ANSI Standard C2) shall be provided – one for each door opening providing access to high voltage. These panels shall be secured in place with recessed pentahead bolts. When so secured, they shall guard against inadvertent contact with live parts.

Q. A (steel non-compartmented) base spacer shall be provided to increase the elevation of live parts in the pad-mounted gear above the mounting pad by 12 inches.

2.6 DOORS

A. Doors shall be constructed of 11-gauge hot-rolled, pickled and oiled steel sheet.

B. Door-edge flanges shall overlap with door opening flanges and shall be formed to create a mechanical maze that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry.

C. Doors shall have a minimum of two extruded-aluminum hinges with stainless steel hinge pins, and interlocking extruded aluminum hinge supports for the full length of the door to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-nickel-plated steel, and shall not be externally accessible to guard against tampering.

D. In consideration of controlled access and tamper resistance, each door (or set of double doors) shall be equipped with an automatic three-point latching mechanism.

1. The latching mechanism shall be spring loaded, and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.

2. A pentahead socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.

3. The latching mechanism shall have provisions for padlocking only when the door is securely latched:

a. It shall not be possible to unlatch the mechanism until the padlock is removed, and

b. It shall not be possible to insert the padlock until the mechanism is completely latched closed.

E. Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.

F. Each door shall be provided with a zinc-nickel-plated steel door holder located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.

2.7 FINISH

A. Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

B. All exterior seams shall be filled and sanded smooth for neat appearance.

C. To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard and underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process comprised of a fully automated system

of cleaning, rinsing, phosphatizing, sealing, drying and cooling before any protective coatings are applied. By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations.

D. After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the enclosure manufacturer's finishing system shall satisfactorily pass the following tests:

1. 4000 hours of exposure to salt-spray testing per ASTM B 117 with:

   a. Underfilm corrosion not to extend more than 1/32" from the scribe as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping); and

   b. Loss of adhesion from bare metal not to extend more than 1/8" from the scribe.

2. 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type Humidity Cabinet with no blistering as evaluated per ASTM D 714.

3. 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB-313 with no chalking as evaluated per ASTM D 659, and no more than 10% reduction of gloss as evaluated per ASTM D 523.

4. Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of finish.

5. 160 inch pound impact adhesion testing per ASTM D 2794 with no chipping or cracking.

6. Oil resistance testing consisting of a 72 hour immersion bath in mineral oil with no shift in color, no streaking, no blistering, and no loss of hardness.

7. 3000 cycles of abrasion testing per ASTM 4060 with no penetration to the substrate.

Certified test abstracts substantiating the above capabilities shall be furnished upon request.

E. After the finishing system has been properly applied and cured, welds along the enclosure bottom flange shall be coated with a wax-based anticorrosion moisture barrier to give these areas added corrosion resistance.

F. A resilient closed cell material, such as PVC gasket, shall be applied to the entire underside of the enclosure bottom flange to protect the finish on this surface from scratching during handling and installation. This material shall isolate the bottom flange from the alkalinity of a concrete foundation to help protect against corrosive attack.

G. After the enclosure is completely assembled and the components (switches, fuses, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish.

H. The finish shall be olive green, Munsell 7GY3.29/1.5.

2.8 CORROSION PROTECTION:

A. To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc-nickel-plated ferrous materials. Cadmiumplated ferrous parts shall not be used.

2.9 INTERRUPTER SWITCHES

A. Interrupter switches shall have a two-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch twice against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.

B. Source-Transfer switch shall be fully automatic primary-selective service and fault protection for one or two critical load circuits on solidly grounded systems.

C. Switch shall contain the following:

1. Stored energy switch operator driven 600-ampere for three-pole live switching of three-phase source circuits.

2. A totally self-contained automatic source transfer package for sensing and control power and programmed control of all switching functions associated with automatic source transfer.

3. Decouplers to permit exercising of the switch operators without affecting the positions of the switches.

4. 200 ampere hookstick operated fuses for single-pole live switching of single-phase or three-phase load circuits.

D. The stored energy switch operator driven on the source circuits provide high speed source transfer for primary selective systems transfer is achieved in 10 cycles, plus any intentional time delay for coordination. The stored energy operators are motor-charged with automatic solenoid trip-open and trip-closed operation. Automatic tripping of the operators is initiated by the Source-Transfer Control, which utilizes an advanced electronic microprocessor to perform control operations in accordance with settings programmed into the device at the factory and in the field. The stored energy operators and source transfer control are isolated from medium voltage in a grounded, steel-enclosed, low-voltage compartment which has fully gasketed door openings.

E. Voltage Sensors – three for each source – provide three-phase sensing, control power, and supply power for motor charging and tripping.

F. Source-Transfer Pad-Mounted Gear features fuses for single-pole live switching of single-phase or three-phase load circuits on distribution systems rated 14.4 kV or 25 kV.

G. Interrupter Switch is also capable of carrying and interrupting load currents up to and including the emergency-peak load capabilities of the associated SML power fuses. In addition to the load dropping capabilities is capable of interrupting transformer magnetizing currents associated with the applicable loads, as well as line-charging and capable charging currents typical for distribution systems of these voltage ratings. The duty cycle fault closing capabilities shown for Interrupter Switch represent the fault-closing capabilities of the fuse when the fuse is closed with a purposeful thrust without hesitation. Following the specified number of such closing (three), the switch will remain operable and able to carry and interrupt rated current.

H. Circuit interruption shall be accomplished by use of an interrupter, which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.

I. Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of switch position.

J. Ground studs shall be provided at all switch terminals. Ground studs shall also be provided on the ground pad in each interrupter switch compartment and on the terminals and ground pad in any bus compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad mounted gear.

K. Key interlocks shall be provided to prevent paralleling the two source interrupter switches.

L. Key interlocks shall be provided to guard against opening fuse-compartment door(s) unless all switches (series tap switch only, where furnished) are locked open.

M. Base mounted distribution class surge arresters; metal oxide type rated 12Kv shall be provided at all source switch terminals.

N. Cable guides shall be provided to help orient cables at switch terminals and bus compartment terminals.

2.10 FUSES

A. Solid Material Power Fuses

1. Fuses shall be disconnect style, solid material power fuses, and shall utilize refill unit and holder or fuse unit and end fitting construction. The refill unit or fuse unit shall be readily replaceable and low in cost.

2. Fusible elements shall be non-aging and non-damageable so that it is unnecessary to replace unblown companion fuses on suspicion of damage following a fuse operation.

3. Fusible elements for refill units or fuse units rated 10 amperes or larger shall be helically coiled to avoid mechanical damage due to stresses from current surges.

4. Fusible elements, that carry continuous current, shall be supported in air to help prevent damage from current surges.

5. Each refill unit or fuse unit shall have a single fusible element to eliminate the possibility of unequal current sharing in parallel current paths.

6. Solid material power fuses shall have melting time-current characteristics that are permanently accurate to within a maximum total tolerance of 10% in terms of current. Time current characteristics shall be available which permit coordination with protective relays, automatic circuit reclosers and other fuses.

7. Solid material power fuses shall be capable of detecting and interrupting all faults whether large, medium, or small (down to minimum melting current), under all realistic conditions of circuitry, with line to line or line to ground voltage across the fuse, and shall be capable of handling the full range of transient recovery voltage severity associated with these faults.

8. All arcing accompanying operation of solid material power fuses shall be contained within the fuse, and all arc products and gases evolved shall be effectively contained within the exhaust control device during fuse operation.

9. Solid material power fuses shall be equipped with a blown fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.

B. Fuse mounting jaw contacts shall incorporate an integral load interrupter that shall permit live switching of fuses with a hookstick.

1. The integral load interrupter housing shall be of the same cycloaliphatic epoxy resin as the insulators.

2. The integral load interrupter shall be in the current path continuously. Auxiliary blades or linkages shall not be used.

3. Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hookstick. No separate load interrupting tool shall be required.

4. The integral load interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation.

5. Internal moving contacts of the integral load interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.

6. Circuit interruption shall take place completely within the integral load interrupter with no external arc or flame.

7. The integral load interrupter and the fuse shall be provided with separate fault closing contacts and current carrying contacts. The fuse hinge shall be self guiding and, together with the fault closing contacts, shall guide the fuse into the current carrying contacts during closing operations. Circuit closing in rush currents and fault currents shall be picked up by the fault closing contacts, not by the current carrying contacts or interrupting contacts.

8. Integral load interrupters for fuses shall have a one time duty cycle fault closing capability equal to the interrupting rating of the fuse, and a two time duty cycle fault closing capability of 13,000 amperes Rms asymmetrical at 14.4 Kv or 25 Kv. The duty cycle fault closing capability defines the level of available fault current into which the fuse can be closed the specified number of times (twice), without a quick make mechanism and when operated vigorously through its full travel without hesitation at any point, with the integral load interrupter remaining operable and able to carry and interrupt currents up to the emergency peakload capabilities of the fuse.

C. Fuse terminal pads shall be provided with a two position adapter, making it possible to accommodate a variety of cable terminating devices.

D. Ground studs shall be provided at all fuse terminals. One ground stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of the ground studs shall equal or exceed the short circuit ratings of the pad mounted gear.

E. Cable guides shall be provided to help orient cables at fuse terminals.

F. A fuse storage compartment shall be provided in two source interrupter switch compartments. Each fuse storage compartment shall provide space for storing three spare fuse holders or fuse units with end fittings for solid material power fuses, or one spare electronic power fuse holder.

PART 3 - EXECUTION

3.1 LABELING

A. Hazard – Alerting Signs

1. All external doors shall be provided with "Warning – Keep Out – Hazardous Voltage Inside – Can Shock, Burn, or Cause Death" signs.

2. The inside of each door shall be provided with a "Danger – Hazardous Voltage – Failure to Follow These Instructions Will Likely Cause Shock, Burns, or Death" sign. The text shall further indicate that operating personnel must know and obey the employer’s work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.

3. Interrupter switch compartments shall be provided with "Danger" signs indicating that "Switches May Be Energized by Backfeed".

4. Fuse compartments shall be provided with “Danger” signs indicating that "Fuses May Be Energized by Backfeed".

5. Barriers used to prevent access to energized live parts shall be provided with "Danger – Keep Away – Hazardous Voltage – Will Shock, Burn, or Cause Death" signs.

B. Nameplates, Ratings, Labels, and Connection Diagrams

1. The outside of each door (or set of double doors) shall be provided with a nameplate indicating the manufacturers name, catalog number, model number, date of manufacture, and serial number.

2. The inside of each door (or set of double doors) shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short circuit ratings (amperes Rms symmetrical and Mva three phase symmetrical at rated nominal voltage); the type of fuse and its ratings include duty cycle fault closing capability; and interrupter switch ratings including duty cycle fault closing and short time (momentary, amperes Rms asymmetrical and one second, amperes Rms symmetrical).

3. A three line connection diagram showing interrupter switches, fuses with integral load interrupter, and bus along with the manufacturer's model number shall be provided on the inside of each door (or set of double doors), and on the inside of each switch operating hub access cover.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. After installing switches but before primary is energized, verify that grounding system at substation is tested at specified value or less.

2. After installing switches and after electrical circuitry has been energized, test for compliance with requirements.

3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Test Reports: Prepare written reports to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

END OF SECTION 26 13 23

SECTION 26 18 16 - MEDIUM VOLTAGES FUSES

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide power fuses in accordance with the Contract Documents.

B. Related Work Specified in Division 26

1. Section 26 05 09 – Testing, Inspection and Certification
2. Section 26 05 13 – Medium Voltage Cables
3. Section 26 05 53 – Identification for Electrical Systems
4. Section 26 12 20 – Pad Mounted Transformers
5. Section 26 13 00 – Medium Voltage Switchgear

C. Related Work Specified under other Divisions of These Specifications

1. None

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. ANSI #C37.40-3.2.2.2

1.3 SUBMITTALS

A. Provide a complete set of shop drawings to include let-through curves for each type of power fuse, a schedule of spare fuse cabinets with a listing of fuses provided within each spare fuse cabinet, and dimensioned drawings of each spare fuse cabinet by type and size.

B. Short circuit current analysis is based upon Bussman fuse characteristics for let-through currents. If Cefco or Chase-Shawmut fuses are to be utilized, it is the Electrical Contractor's responsibility to provide the appropriate fuse curves and let-through values which correspond to the Bussman values shown on the Drawings. Submit comparative chart of fuse substitutions for Architect/Engineer and for respective Building Department review prior to acceptance of same substitutions.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Fuses

1. Bussman
2. Cefco
3. Chase-Shawmut
4. S & C

B. Spare Fuse Cabinet

1. By fuse suppliers

2.2 MATERIALS

A. Mains and Feeders

1. General

a. All power fuses shall be "E" rated and labeled as UL Class G current limiting and rated for 100,000 AIC symmetrical fault.

b. All fuses shall have the following capabilities:

1) Shatterproof body
2) Silver plated contacts
3) Silent non-venting interruption
4) Integral non-explosive blown fuse indicator

2. All fuses shall be so selected as to provide a selectively coordinated system.
3. All fuses shall be of the same manufacturer.
4. All fuses to be of the current limiting type.

B. Spares - upon completion of the building, the contractor shall provide the Owner with spare fuses as indicated below:

1. 10 percent (minimum of 3) of each type and rating of installed fuses shall be supplied as spares.

2. Spare fuse cabinets shall be provided to store the above spare fuses. Fuses 600V and less shall be in separate cabinet.

3. Spare fuse cabinets shall be provided as a minimum in the following locations:

a. Each main switchgear room that is applicable.

PART 3 - EXECUTION

3.1 GENERAL

A. Fuses shall not be installed until equipment is ready to be energized.

B. Provide and install fuses of proper type, voltage and ampere readings for all fusible devices furnished under this Section and all other sections of this specification.

END OF SECTION 26 18 16

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes service and distribution switchboards rated 600 V and less.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. RFI: Radio-frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.

b. Bus configuration, current, and voltage ratings.

c. Short-circuit current rating of switchboards and overcurrent protective devices.

d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.

e. Mimic-bus diagram.
f. UL listing for series rating of installed devices.
g. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified finish, for color selection.

D. Manufacturer Seismic Qualification Certification: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Components." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For testing agency.

F. Field quality-control test reports including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

G. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.

1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

B. Source Limitations: Obtain switchboards through one source from a single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."

F. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections or lengths that can be moved past obstructions in delivery path. **Provide weather protection for all components during delivery.**

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.7 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect and Owner no fewer than 14 days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Owner's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than 2 of each size and type.

2. Control-Power Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than 2 of each size and type.

3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.

4. Fuses for Fused Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.

5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.

6. Indicating Lights: Equal to 10 percent of amount installed for each size and type, but no fewer than 1 of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MANUFACTURED UNITS

A. Manufacturers:

1. Square D.

B. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.

C. Nominal System Voltage: 480Y/277 V and 208Y/120 V.

D. Main-Bus Continuous: As noted on drawings.

E. Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Components."

F. Enclosure: Steel, NEMA 250, Type 1.

G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

H. Barriers: Between adjacent switchboard sections.

I. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

J. Provide digital multifunction metering to switchboard with display.

K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

L. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.

M. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

N. Buses and Connections: Three phase, four wire, unless otherwise indicated. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.

2. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with copper- or tin-plated, aluminum circuit-breaker line connections.

3. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.

a. If bus is aluminum, use copper- or tin-plated aluminum for circuit-breaker line connections.

b. If bus is copper, use copper for feeder circuit-breaker line connections.

4. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuit-breaker position.

5. Ground Bus: 1/4-by-2-inch-minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

6. Contact Surfaces of Buses: Silver plated.

7. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Cable connected busses are not permitted unless specifically shown on the drawings or permission is granted in writing from the owner or Architect/Engineer. Provide for future extensions from both ends.

8. All compartments shall be bussed to maximize breaker space and utilization.

9. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

10. Neutral Buses: 50 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

11. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

O. Future Devices: Every available compartment or space where a circuit breaker can be mounted, shall have all the provisions necessary to mount a device of the largest size available for that space, whether call for on the drawings or not. Every compartment shall be fully bussed to accept these devices. Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

P. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating: 105 deg C.

2.3 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.

B. Minimum single-impulse current rating shall be as follows:

1. Line to Neutral: 100,000
2. Line to Ground: 100,000
3. Neutral to Ground: 50,000

C. Protection modes shall be as follows:

1. Line to neutral.
2. Line to ground.
3. Neutral to ground.

D. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.

E. Maximum Category C combination wave clamping voltage shall not exceed 600 V, line to neutral and line to ground on 120/208 V and 1000 V, line to neutral and line to ground on 277/480 V systems.

F. Maximum UL 1449 clamping levels shall not exceed 400 V, line to neutral and line to ground on 120/208 V and 800 V, line to neutral and line to ground on 277/480 V systems.

G. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.

H. Accessories:

1. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.

2. Audible alarm activated on failure of any surge diversion module.

3. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. General: Circuit breakers with adjustable trip settings shall be such that the maximum trip setting will be equal to the circuit beaker frame size specified. Micrologic trip breakers with adjustable settings shall be provided for all breakers rated for 100A and greater.

B. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single and two-pole configurations with [**5**] [**30**]-mA trip sensitivity.

C. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

2. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

5. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

D. Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased-power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Microprocessor-based trip units with interchangeable rating plug, LED trip indicators, and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments with I^2t response.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Remote trip indication and control.
5. Control Voltage: 125-V, ac.

E. Circuit breaker options:

1. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

2. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

3. Electric Close Button: One for each electrically operated circuit breaker.

4. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

5. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage. Provide electronically actuated trip devices and sensors so that the breaker automatically resets.

6. Shunt-Trip Devices: Where indicated.

7. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.

3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.

b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

d. Megawatts: Plus or minus 2 percent.

e. Megavars: Plus or minus 2 percent.

f. Power Factor: Plus or minus 2 percent.

g. Frequency: Plus or minus 0.5 percent.

h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.

i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.6 CONTROL POWER

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Furnish one portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Furnish overhead circuit-breaker lifting device, mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

F. Fungus Proofing: Permanent fungicidal treatment for switchboard interior, including instruments and instrument transformers.

2.8 IDENTIFICATION

A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

B. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

C. System Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:

1. Frame size of each circuit breaker.
2. Trip rating for each circuit breaker.
3. Conduit and wire size for each feeder.

PART 3 - EXECUTION

3.1 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 EXAMINATION

A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.

B. Install and anchor switchboards level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 26 Section "Electrical Supports and Seismic Restraints," and concrete materials and installation requirements are specified in Division 03.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

2. For switchboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install spare-fuse cabinet.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 53 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.

c. Instruments, Equipment, and Reports:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2) Prepare a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 24 13

SECTION 26 24 16 – PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General – provide panelboards in accordance with the Contract Documents.

B. Related Work Specified in Division 26

1. Section 26 05 26 – Grounding and Bonding
2. Section 26 05 53 – Identification for Electrical Systems
3. Section 26 28 14 – Fuses – Low Voltage
4. Section 26 50 16 – Alternatives

C. Related Work Specified in other Divisions of these Specifications.

1. Finish Painting

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and recommendations of the following:

1. Panelboards

a. U.L. Standards #50 & #67
b. Federal Standard W-P-115A Type II, Class I and W-C-375B
c. NEMA Standard PB-1-1971

2. Circuit Breakers

a. U.L. Standard #489
b. Federal Standard W-C-375A Amendment No. 4
c. NEMA Standard AB-1-1969

1.3 SUBMITTALS

A. Refer to Section 26 05 05 concerning the procedures and additional documents for submittals in concert with panelboard submittals. Submittals failing to meet the following criteria will be returned without a review or acceptance.

B. With each panelboard drawing the following is required:

1. Show main devices and lug sizes; branch circuit device sizes and arrangement; bus ampacities; withstandability and short circuit rating; dimensions and construction; gutter

and backbox dimensions; nameplate and legend; protective coating; and all pertinent details of panel, enclosure, cover, and method of securing cover and lock.

1.4 QUALITY ASSURANCE

A. Each panelboard as a complete and finished product shall receive a single integrated equipment rating by the manufacturer. The integrated equipment short circuit wiring shall certify that all equipment is capable of withstanding the thermal and magnetic stress of a fault equal to the value specified on the Drawings. Such rating shall be established by actual tests by the manufacturer on similar equipment. This certification shall be permanently affixed to each panelboard. Test data shall be submitted to the Engineer at time of submission of Acceptance Drawings.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D Co.
2. Siemens Energy and Automation, Inc.
3. Eaton

B. 277/480 volts circuit breaker type panelboards are to be equal to Square D NF or TYPE ILine.

C. 120/208 volts circuit breaker type panelboards are to be equal to General Electric Type NQOD.

2.2 PANELBOARDS IN GENERAL

A. Provide panelboards consisting of an assembly of branch circuits switching and protective devices (circuit breakers, switch and fuse units, or combination thereof) mounted inside a dead front enclosure. Provide the number and size of these branch circuit devices as indicated by the circuiting, on the drawings, and in the schedules. Locations of circuit breakers shall be as indicated in the schedules.

B. Provide the following modifications and additional equipment as shown on the Drawings:

1. Main circuit breakers
2. Shunt trip circuit breakers
3. Double lugs for multiple cables or for future provisions
4. Ground fault interrupting circuit breakers
5. Oversized gutters
6. Door in door construction for power panels

C. Interiors

1. Rigid removable assembly of copper bus bars and interchangeable bolted branch circuit devices.

2. Bus bars drilled to permit branch circuit devices of all sizes and number of poles to be interchangeable and installed in any spare space of sufficient size, without disturbing adjacent units; without removing main bus or branch circuit connectors and without machining, drilling, or tapping in the field.

3. Arrange bus in sequence or distributed phasing so that multipole circuit breaker can replace any group of single circuit breakers of the same size.

4. Provide ground bus in each panelboard. On 120/208 volt panelboards provide isolated ground bus where required.

D. Enclosure

1. Code gauge steel box galvanized
2. Provide a bolt-on ground connector to inside of enclosure.
3. Flush mounted in finished areas and where indicated. Surface mount elsewhere.

E. Front

1. Doors must be provided on all lighting and power panels. On switch and fuse panelboards doors over overcurrent devices are not to be provided unless rated for same.

2. Heavy code gauge steel as required to maintain panel face flat.

3. Hold front closed with trim clamps.

4. Factory finished in medium gray enamel or two coats of air-drying lacquer over a rust inhibitor.

5. Provide directory for total number of poles.

6. Provide approved lock. All panels keyed alike. Furnish four (4) sets matching keys to the Owner.

7. Welded angle rest at the bottom of the door to facilitate cover installation.

8. Door over 48" in height shall have auxiliary fasteners at top and bottom of door in addition to lock and catch.

F. Multiple Section Panelboards

1. Each section of multiple section panelboards shall be the same height.
2. Multiple sections shall each contain the same number of poles (e.g. 72 poles equal 2-36 pole panels).

G. Terminal Lugs

1. Bolted type, labeled for either copper or aluminum conductors.
2. Locate main lugs properly at top or bottom, depending where main feeder enters.

H. Electrical Ratings

1. Panelboards are to be rated 120/208 volts or 277/480 volts, three (3) -phase, Four (4) wire, full neutral with ampacities as indicated on the Drawings (unless otherwise noted).

2. Short circuit withstand ratings shall be as indicated on the Drawings.

I. Circuit Breaker Devices

1. Plastic molded case bolt-on type. Plug-on or plug-in type breakers are unacceptable. Completely sealed enclosure. Toggle type operating handle. Trip ampere rating and ON/OFF indication clearly visible.

2. Thermal-magnetic trip-free, trip-indicating, quick-make, quick-break, with inverse time delay characteristics for breakers rated below 100A. Single handle and common tripping multipole breakers.

3. Micrologic adjustable trip breakers shall be provided for all breakers rated over 100A.

4. Silver alloy contacts with auxiliary arc-quenching devices.

5. Panelboard must be of the type which will accept the field installation of shunt trip devices of 60 amperes or less on the branch devices.

6. Interrupting capacities shall be "fully rated" with AIC ratings as indicated on the Drawings. As a minimum, 120/208 volt devices shall be not less than 10,000 AIC and 277/480 not less than 14,000 AIC.

7. For lighting circuits provide devices labeled "SWD" for switching purposes.

8. Bolted type terminals U.L. listed for either aluminum or copper 75 degrees C cables.

9. Provide main breakers in panels served from transformers unless separate transformer secondary protection is provided.

10. Locate next to each breaker or space unit an individual number.

11. Circuit breakers serving elevators, computer equipment and those serving kitchen equipment beneath cooking hoods shall include a shunt trip coil.

12. Shunt trip breakers shall be supplied with 120 volt coils. Provide 120 volt circuit from nearest 120 volt panel to coil. Where shunt trip breakers are in emergency panels provide emergency 120 volt source for same from nearest 120 volt emergency panel.

13. Provide locking device for designated breakers.

14. For HVAC equipment, provide UL listed: HACR type devices.

J. Ground Fault Interrupters

1. Ground fault interrupter branch circuit breakers shall be as indicated on the Drawings. Circuit breakers shall be circuit interrupting which will operate manually for normal switching functions and automatically under overload, short circuit, and 0.005 amp line-to-ground fault conditions. The operating mechanism shall be entirely trip-free so that contact cannot be held close against an abnormal overcurrent, short circuit, or ground fault condition. The device shall be bolt-on type with case construction and shall be interchangeable with standard 1P breakers utilized in the panelboard.

2. All snow melting equipment shall be served from GFI breakers.

K. Future Devices

1. Any space within breaker (or switch) mounting area where a breaker (or switch) may be mounted, shall be bussed and fully equipped to accept a breaker (or switch) without any further modifications to the panelboard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount all panels at a maximum height of 6 feet 6 inches to top unless otherwise noted.

B. Mount surface type panels a minimum one (1) inch off wall on channels.

C. Connect feed through panels to main feeder by insulated parallel gutter taps (O.Z. Electrical Manufacturing Co. – Type PMX or PMX-C). Full size tap for two panels on a common feeder, half the main cable capacity for three or more panels per feeder.

D. Where flushed mounted, the fire integrity of the wall in which it is installed must be maintained.

E. Neatly arrange branch circuit wires and tie together in each gutter with Thomas & Betts nylon "Ty-Raps", or approved equal at minimum (4) four inch intervals.

F. Plug all knockouts removed and not utilized.

G. Provide nameplate and fill out panel directory per Section 26 05 53.

H. Provide grounding and bonding jumpers per Section 26 05 26 and as indicated on the Drawings.

3.2 TOUCH UP AND CLEANING

A. Vacuum all backboxes clean of debris after installation and prior to final payment.

B. Touch up scratch marks, etc. with matching paint.

3.3 OBSERVATIONS

A. All panel fronts shall be removed by the Contractor for observation of the panel interiors by the Engineers.

B. Panel fronts shall be removed when directed by the Engineer/Architect for observation (either by floor, or by group of floors on all panels on the project as required by the Engineer/Architect) and reinstalled immediately thereafter the observations.

END OF SECTION 26 24 16

SECTION 26 27 19 - MULTI-OUTLET ASSEMBLIES

PART 1 - GENERAL

1.1 GENERAL

A. General: Provide multi-outlet assemblies in accordance with the Contract Documents.

1.2 STANDARDS

A. Except as modified by governing codes and the Contract Documents, comply with the applicable provisions and latest recommendations of the following:

1. UL5.

1.3 SUBMITTALS

A. Submit shop drawings and manufacturers' data in accordance with the conditions of the Contract and as specified below:

1. Submit manufacturers' catalog cuts and specifications for multi-outlet assemblies. Submittal shall include but is not limited to, wiring devices, mounting and installation methods, and all fittings, connectors and coverplates.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Wiremold, Plugmold Series V-3000 or approved equal, color as selected by architect.

B. Hubbell

2.2 GENERAL

A. Wiring Devices

1. Receptacles shall be 20A, 125V, 3 wire grounding type. Receptacle spacing shall be 12" on center unless noted otherwise. Total raceway length shall be as shown on the Drawings.

B. Wire

1. All assemblies shall provide a separate ground wire. Use of the raceway for grounding purposes is not allowed.

2. All conductors shall be copper with type THHN or THWN insulation.

C. Raceways

1. Raceway construction shall be a minimum of .04" sheet steel.

2. Raceway cover shall be removable along the complete and continuous length of the assembly.

3. Raceway cover shall snap onto the body of the raceway and must provide a secure cover connection that will not become unintentionally unattached under normal use.

4. Raceway finish shall be factory applied enamel paint or stainless steel. Standard colors are buff or grey unless noted otherwise as color by Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be done in a workmanlike manner, complete with all raceway joints provided with coverplates and other necessary fittings for a neat installation.

B. No power circuit wiring other than that providing power to the multi-outlet assembly shall be allowed within the raceway.

C. All wire splices shall be done in accordance with Section 26 05 21 of this Specification.

D. All wires extending beyond the last receptacle on the assembly shall be provided with wire nut terminations and the raceway shall be provided with an end fitting.

E. No cord and plug connected multi-outlets assemblies are allowed. All power connections to multi-outlet assemblies shall be permanent.

F. Raceways shall be installed partially recessed or surface mounted. No raceways may extend through or be contained in a partition.

G. Wiring within the raceway shall be supported a minimum of 30" on center and at each splice or raceway connection point.

END OF SECTION 26 27 19

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide wiring devices in accordance with the Contract Documents.

B. Related Work Specified in other Divisions of these Specifications.

1. Finish painting.

C. Color: The numbers shown are for ivory. Confirm the color of devices and plates with the Owner/Architect prior to submitting shop drawings or ordering any materials.

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Switches

a. Federal Specifications Standard WS-896E.

2. Receptacles

a. N.E.M.A. Standard WD-1, 3.2 through 3.10.
b. U.L. Standard 498 Federal Specification WC596-D.
c. ANSI.

1.3 SUBMITTALS

A. Submit manufacturer's catalog cuts and specifications for all wiring devices and plates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following manufacturers, shortened versions (shown in parentheses), are approved for submission of their products. Other manufacturers may be used, only with approval by the Owner (other).

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).

4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Hubbell; HBL5361 (single), HBL53621 (duplex).

B. Hospital-Grade, Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.

1. Hubbell; HBL83101 (single), HBL83001 (duplex).

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Hubbell; HBL8300SG1A.
2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Hubbell; GF5362A

C. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.

1. Hubbell; GF8300A.

2.4 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Hubbell; HBL2310.

2.5 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.6 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Hubbell; HBL12211 (single pole), HBL12221 (two pole), HBL12231 (three way), HBL12241 (four way).

C. Pilot Light Switches, 20 A:

1. Hubbell; HBL1221ILC for 120 V and 277 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Hubbell; HBL1221L1.
2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Hubbell; HBL15571.

2.8 OCCUPANCY SENSORS

A. Wall-Switch Sensors:

1. Hubbell; WS1277.
2. Watt Stopper (The); WS-200.

3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..

B. Long-Range Wall-Switch Sensors:

1. Hubbell; ATP1600WRP.
2. Watt Stopper (The); CX-100.
3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft..

C. Wide-Range Wall-Switch Sensors:

1. Hubbell; ATP120HBRP.
2. Watt Stopper (The); CX-100-3.
3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft..

2.9 COMMUNICATIONS OUTLETS

A. Telephone Outlet:

1. Cooper; 3560-6.
2. Leviton; 40649.
3. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 6e. Comply with UL 1863.

B. Combination TV and Telephone Outlet:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 3562.
b. Leviton; 40595.

3. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

2.10 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Finished Spaces: High impact plastic, stainless steel in operating rooms.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Thermoplastic with lift cover, and listed and labeled for use in "wet locations" while in use.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, thermoplastic with lockable cover. Labeled for "while in use."

2.11 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.12 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
3. Wiremold Company (The).

B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.

1. Service Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks.

2. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.

3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

4. Closure Plug: Arranged to close unused 3-inch cored openings and reestablish fire rating of floor.

5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 6e voice and data communication cables.

2.13 MULTIOUTLET ASSEMBLIES

A. Manufacturers:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Wire: No. 12 AWG.

2.14 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

1. Poles: Nominal 2.5-inch-square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.

2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.

3. Finishes: Manufacturer's standard painted finish and trim combination.

4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 6 voice and data communication cables.

5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.

6. Voice and Data Communication Outlets: Blank insert with bushed cable opening.

2.15 FINISHES

A. Color: Wiring device catalog numbers in Section Text a reference to the rating or style of device required. Final color selection shall be by the Owner or Architect.

1. Wiring Devices Connected to Normal Power System: As selected by Owner/Architect, unless otherwise indicated or required by NFPA 70 or device listing.

2. Wiring Devices Connected to Emergency Power System: [Red] <Insert color>.

3. TVSS Devices: Blue.

4. Devices fed from UPS shall be grey in color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise required by ADA or indicated in Section 26 05 00.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 16 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with [black] [white] [red]-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

END OF SECTION 26 27 26

SECTION 26 28 14 - FUSES-LOW VOLTAGE

PART 1 - GENERAL

1.1 SUMMARY

A. General

1. Provide fuses in accordance with the Contract Documents.

B. Related Work in Specification Division 26

1. Section 26 24 16 – Panelboards
2. Section 26 24 19 – Motor Control Center
3. Section 26 28 23 – Disconnect Switches – Fused and Non-Fused

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. UL Standard #198
2. UL Standard #977

1.3 SUBMITTALS

A. Provide a complete set of shop drawings to include let-through curves for each type of fuse.

B. Submit listing of all types, sizes and quantity of fuses which will be installed including the location of each.

C. Submit listing of all spare fuses by types, sizes and quantities, which will be furnished for placement in the respective fuse cabinets.

D. Submit dimensioned drawings of each fuse cabinet by type and size.

E. Short circuit current analysis is based upon Bussman fuse characteristics for let-through currents. If Reliance, Cefco or Gould-Shawmut fuses are to be utilized, it is the Electrical Contractor's responsibility to provide the appropriate fuse curves and let-through values which correspond to the Bussman values shown on the Drawings. Submit comparative chart of fuse substitutions for Architect/Engineer and for respective Building Department review prior to acceptance of same substitutions. Comparative chart shall include the following:

1. Cross reference of fuses to be used in place of Bussman fuse type designation indicated on the drawings or specified herein.

F. Submit proof of coordination with the power company for any fuses associated with electric service.

G. Fuses shall comply with the recommendations of the Fault Current and Coordination Study.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Fuses

1. Bussman
2. Cefco
3. Gould-Shawmut
4. Reliance

B. Spare Fuse Cabinet

1. By fuse supplier.

2.2 MATERIALS

A. Mains, Feeders, and Branch Circuits

1. General

a. All fuses shall be labeled as UL Class L or UL Class R, current limiting and rated for up to 200,000 amperes. Time delay Class R fuses shall be so labeled.

2. Main Service and All Feeder-Circuits

a. Fuses over 600 amperes shall be UL Class L. Fuses up to 600A shall be UL class RK1 labeled Time-delay.

3. Branch Circuits

a. Unless noted otherwise on the drawings, all fuses up to 600A shall be UL Class RK5 labeled Time-delay.

4. All fuses shall be so selected as to provide a selectively coordinated system.

5. All fuses shall be of the same manufacturer.

B. Spares

1. Upon completion of the building, the contractor shall provide the Owner with spare fuses as indicated below:

a. 10 percent (minimum of 3) of each type and rating of installed fuses shall be supplied as spare.

b. Spare fuse cabinets shall be provided to store the above spares.

c. Spare fuse cabinets shall be provided as a minimum in the following locations.

1) Each main switchgear room.
2) Each major mechanical equipment room.

C. Labels

1. Paste-on labels for building standard fuses of 600A and below to read:

EXAMPLE:

"WARNING: INSTALL CLASS RK1 FUSES ONLY."

D. Coordination

1. All fuses associated with electric service shall be coordinated with the power company prior to ordering any fuses.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fuses shall not be installed until equipment is ready to be energized. Verify the proper fuse size before ordering, regardless of sizes shown on drawings.

B. Provide and install fuses of proper type, voltage and ampere ratings for all fusible devices furnished under this section and all other sections of this specification.

C. Labels

1. Paste appropriate label within each switch, motor starter, or panelboard door or at location next to fuse clips, where fuses shall be furnished and installed by this Contractor. Fill-in, in ink blank spaces on labels for non-standard fuses with appropriate fuse data.

END OF SECTION 26 28 14

SECTION 26 28 16 - ENCLOSED LOW VOLTAGE CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under the Section.

B. Section Includes:

1. Enclosed molded case circuit breakers.

C. Related Sections:

1. Division 01 Section “General Requirements.”
2. Division 01 Section “Special Procedures.”
3. Division 26 Section “Common Work Results - Electrical.”
4. Division 26 Section “Inspections and Testing, Inspection and Certification.”
5. Division 26 Section “Wires and Cables.”
6. Division 26 Section “Pathways for Communication Systems.”
7. Division 26 Section “Grounding and Bonding.”
8. Division 26 Section “Raceways and Boxes.”
9. Division 26 Section “Overcurrent Protective Device Coordination Study.”

1.2 REFERENCES

A. General

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.

2. Unless otherwise noted, the edition of the referenced code or standard that is current at the time of the “date of record” for the Work shall be considered the effective code or standard for the duration of the project.

3. Refer to Division 01 Section “General Requirements” for the list of the applicable regulatory requirements.

4. Refer to specific Division 26 Sections for additional referenced codes and standards.

B. ANSI/NFPA 70 – National Electrical Code

C. NFPA – National Fire Protection Association:

1. Standard for Electrical Safety in the Workplace (NFPA 70E)

D. NEMA – National Electrical Manufacturers Association:

1. NEMA 250 – Enclosures for Electrical Equipment
2. NEMA AB1 – Molded Case Circuit Breakers

E. UL – Underwriters' Laboratories:

1. UL 489 – Molded Case Circuit Breakers and Enclosures

1.3 SUBMITTALS

A. Shop Drawings: The Subcontractor shall submit for approval Shop Drawings prepared in accordance with Division 01 Section "General Requirements", and as required by other sections of the specifications.

B. All submittals and shop drawings shall be reviewed and approved by the A/E before procurement or fabrication of material and equipment.

C. Submit five (5) copies of Product Data and Shop Drawings for equipment and component devices. Include time-current curves of circuit breaker trip units.

1. Include dimensional outline drawings; conduit entrance locations and requirements; voltage rating, continuous and short-circuit current ratings; cable terminal sizes and temperature ratings.

D. Operation and Maintenance Data:

1. Maintenance Data: Furnish five (5) copies of recommended maintenance procedures and intervals. Include spare parts data listing; source and current prices of replacement parts and supplies.

2. Furnish Time-Current curves of circuit breaker trip units. Time-Current curves shall be first generation originals on full size 11 by 17 inches paper.

1.4 QUALITY ASSURANCE

A. Products shall be tested, approved and label/listed by Underwriters Laboratories, Inc., or by a nationally recognized testing laboratory (NRTL) as listed in Division 26 Specification "Common Work Results - Electrical."

B. Electrical Equipment and materials shall be new and within one year of manufacture, complying with the latest codes and standards. No used, re-built, refurbished and/or re-manufactured electrical equipment and materials shall be furnished on this project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in unopened cartons or bundles as appropriate, clearly identified with manufacturer's name, Underwriter's or other approved label, grade or identifying number.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to equipment and material from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.6 WARRANTY

A. Warranty: Warranty period of one (1) year minimum shall start at the date the equipment is energized after acceptance by the University. Submit five (5) copies of the warranty certificate to the University.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Schneider-Square D

B. General Electric

C. Siemens Energy & Automation, Inc.

D. Eaton/Cutler-Hammer

E. Or Approved Equal

2.2 MOLDED CASE PROTECTIVE DEVICES

A. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.

B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.

C. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.

D. Circuit breakers 15 to 100 ampere frame shall be provided with fixed thermal-magnetic trip units.

E. Circuit breakers 100 ampere frame and above shall be provided with micro-processor-based RMS sensing trip units with features noted on the drawings. Trip mechanisms shall be provided with the following trips: instantaneous, long-time pickup, long time delay, short time pickup, short time delay, 12t function, ground fault pickup, ground fault delay.

F. Circuit breakers for HVAC and refrigeration unit equipment shall be listed by UL as Type HCAR.

2.3 ACCESSORIES

A. Provide accessories as indicated on the Drawings.

B. Shunt Trip Device: Coil rated for 120 volts, AC.

2.4 ENCLOSURES

A. Provide enclosures fabricated from steel suitable for locations as indicated on the drawings and as described below:

1. NEMA 1 surface or flush-mounted general purpose enclosures intended for indoor use.

2. NEMA 12 dust-tight enclosures intended for indoor use to provide protection against circulating dust, falling dirt and dripping non-corrosive liquids.

3. NEMA 3R rain-tight enclosures intended for outdoor use in damp locations or to provide protection against rain.

4. NEMA 4/4X watertight stainless steel intended for indoor or outdoor use to provide protection against windblown dust and rain, splashing rain, hose-directed water, and damage from corrosive agents.

5. NEMA 7, Class I, Group C and D hazardous location cast aluminum intended for indoor use on locations classified as Class I, Group C and D as defined in the National Electrical Code.

6. NEMA 9, Class II, Groups E, F, and G hazardous location aluminum intended for indoor use in locations classified as Class II, Groups E, F, and G as defined in the National Electrical Code.

B. Provide a factory installed ground termination block sized for the grounding conductor indicated on the Drawings.

C. Provide operator handle mechanisms that are padlock-able in the “OFF” position. In the case of electrically operated breakers, provide a permanently installed device for padlocking in the “OFF” position.

D. All enclosed circuit breakers shall have nameplates that contain a permanent record of catalog number and maximum rating.

E. Enclosures shall be finished using the manufacturer's standard process and shall be ANSI 61 gray (___) color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install circuit breaker enclosures plumb with suitable supports and per manufacturer's recommendations. Where mounted on concrete wall, install with 1/2 inch steel spacers behind the switch enclosure. Mounting attachments and connections shall be designed in conformance with the minimum lateral seismic force of 0.5W per CBC.

B. Height: Install top of circuit breaker enclosure 78 inches above finished floor, unless otherwise noted on drawings.

C. Provide engraved nameplates with the designation indicated on the Drawings. Include "Fed from xxxxxx"

D. Perform field adjustments of the circuit breakers as required to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device coordination study or as directed by the Project Manager.

3.2 FIELD QUALITY CONTROL

A. Comply with requirements of NETA Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems and the manufacturer's inspection, testing, calibration and start-up procedures. The manufacturer's technician shall perform inspection, testing, calibration and start-up with assistance from the Subcontractor as necessary, and in the presence of owner's representative. Schedule testing and start-up with at least ten (10) working days advance written notification.

B. Visual and Mechanical Inspection: Verify circuit breaker frame size and type, enclosure type and required accessories are installed. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and check tightness of connections with a calibrated torque wrench. Verify trip unit type, ratings and settings of overcurrent protective devices are in conformance with the approved Electrical System Studies for the project.

C. Electrical Tests: Measure and record insulation resistance of the enclosed circuit breaker and its components (phase-to-phase and phase-to-ground) prior to energization. The Subcontractor shall not be responsible for defective insulation in equipment that has been supplied by the University, unless such damage is due to negligence or incorrect handling or installation workmanship of the Subcontractor.

1. The insulation resistance of each circuit phase-to-phase and phase-to-ground shall be measured. For circuits rated less than 600 volts, the resistance shall not be less than 100 megohms.

2. Systems rated above 240 volts shall be tested with a 1000-volt Megohmeter. Circuits rated 240 volts and below shall be tested with a 500-volt Megohmeter. The D.C. potential shall be applied for thirty (30) seconds.

D. The Subcontractor shall submit to the Project Manager five (5) copies of test results, certified in writing, witnessed, signed and dated, immediately upon completion of work for review and acceptance by the University. An unsatisfactory condition revealed by these test results, or unsatisfactory methods of tests and/or testing apparatus and instruments, shall be brought to the attention of the Project Manager. Corrections by the Subcontractor shall be validated by re-tests to the satisfaction of the Project Manager.

E. The Project Manager reserves the right to require that the Subcontractor perform and repeat tests that are deemed necessary to complete or check the tests or the certified records of the Subcontractor at any time during the course of the work. The Subcontractor shall correct unsatisfactory portion of his work that is revealed by the tests or that may be due to progressive deterioration during this period, unless the item in question was a direct specification.

3.3 ACCEPTANCE AND ENERGIZATION

A. Final acceptance shall depend upon the satisfactory tests results as performed in accordance with the manufacturer's instructions. After tests have been reviewed and approved by the Owner, energization may proceed.

B. Upon energization test and record readings for proper voltages, correct phase rotation and phase sequence (A-B-C) for both incoming and outgoing feeder or branch circuits. Provide Owner with five (5) certified copies of filed test reports.

END OF SECTION 26 28 16

SECTION 26 28 23 - DISCONNECT SWITCHES - FUSED AND NON-FUSED

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide fused and unfused disconnect switches in accordance with Contract Documents.

B. Related Work Specified in Division 26

1. Section 26 28 14 – Fuses – Low Voltage
2. Section 26 05 26 – Grounding and Bonding
3. Section 26 05 53 – Identification for Electrical Systems

C. Related Work Specified in other Divisions of these Specifications.

1. Setting of motors and other equipment.

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and the latest applicable recommendations of the following:

1. U.L. Standards #98 (File #4776) and #508.
2. Federal Specifications W-S-865C.
3. NEMA Standard KS1-1975.
4. U.L. 20 and Federal Specification Test Standards for Toggle Switches.

1.3 SUBMITTALS

A. Submit manufacturer's data for all disconnect switches.

B. Identify motor or equipment served by each switch; indicate nameplate inscription.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Safety switches.

1. Shall be of the same manufacturer as the panelboards.

B. Toggle type manual control switches.

1. Square D Class 2510, 11, 12.
2. Siemens Class SMF
3. General Electric Type RB with enclosure.

2.2 SAFETY SWITCHES

A. Heavy-duty, horsepower rated, single-throw knife switch with quick-make, quick-break mechanism, capable of full load operations. Meet NEMA and U.S. Government specifications for Class A switches.

B. Provide with contact arc-quenching devices, such as magnetic blowouts or snuffing plates. Provide self-aligning switchblades with silver alloy contact areas and designed so that arcing upon making and breaking does not occur on the final contact surfaces. Provide with high-pressure, spring-loaded contact. Mount switch parts on high-grade insulating base.

C. Enclosure – NEMA 1 with hinged door and defeatable interlock when switch is in "ON" position and can be positively padlocked in "ON" and "OFF" positions. Utilize NEMA 3R (rain-tight) enclosure for exterior installations. Use stainless steel NEMA 4X, where indicated in documents.

D. Size, fusing and number of poles as shown or as required. Where fused, the devices must be provided with UL listed rejection feature to reject all but Class R fuses. Provide horsepower rated switch to match motor load if no size is shown. Use 3 pole plus solid neutral switches on four wire circuits and 3 pole switches on all other circuits, unless otherwise noted.

E. Lugs must be UL listed for aluminum and/or copper conductors and be front removable.

F. Provide six (6) pole switches for connection to motors with the following starter types:

1. Non-reversing – two-step – part winding – star connected.
2. Non-reversing – full voltage – two speed separate winding.
3. Non-reversing – full voltage – two speed single winding.
4. Where otherwise required.
5. Provide auxiliary contacts for switches where required or where indicated on the drawings.

2.3 TOGGLE TYPE MANUAL CONTROL SWITCHES

A. Provide switches that operate at their full rating with fluorescent, tungsten and resistance loads, and at 80% of their rated capacity with motor loads.

B. Switches to be heavy duty and have:

1. Arc-resisting bodies.
2. Slow make-and-break mechanisms
3. Silver alloy contact buttons
4. Side or back wiring with up to No. 10 AWG solid conductors

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Each motor over 1/2 HP shall be provided with a horsepower-rated safety-type disconnect switch.

B. Each piece of equipment utilizing multi-phase power shall be supplied with a safety-type disconnect switch.

C. Each piece of equipment utilizing single-phase power but protected at over 30 amperes shall be supplied with a safety-type disconnect switch.

D. Equipment other than that mentioned above may utilize a toggle type manual control switch properly sized and rated for the equipment it disconnects.

E. Factory installed disconnect switches may be used to satisfy the above requirements with the Architect/Engineer's prior approval.

3.2 MOUNTING

A. Provide connections and wiring to and from each disconnect switch. Support conduit feeder from ceiling or floor.

B. Disconnect switches shall be mounted at adjacent wall or from the floor with independent supports. Switches shall not be mounted on fan housings.

C. Mount switch enclosure rigidly and with proper alignment on building structure or steel supports with centerline of operating handle not more than 6 feet above finished floor unless otherwise required. Use steel supports fabricated from standard rolled structural steel shapes or framing channel to provide one-inch separation between enclosure and building wall for vertical flow of air.

D. Install fuses as specified in Section 26 28 14.

E. Completed installation shall contain no extraneous openings.

3.3 IDENTIFICATION

A. Provide identification of all disconnect switches in accordance with Section 26 05 53 of these specifications.

END OF SECTION 26 28 23

SECTION 26 29 13 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide enclosed controllers, (individual motor controllers) in accordance with the Contract Documents.

B. Related Work Specified in Division 26

1. Section 26 05 10 –Testing, Inspection and Certification
2. Section 26 05 25 – Grounding and Bonding
3. Section 26 05 53 – Identification for Electrical System
4. Section 26 28 14 – Fuses – Low Voltage

C. Related Work Specified in Other Divisions of These Specifications

1. Motors
2. Control Wiring (except as otherwise noted)

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. U.L. Standards 508, 547, 845 and 1004
2. NEMA Standard ICS

1.3 SUBMITTALS

A. Submit the following manufacturer's data and shop drawings for each individual motor controller:

1. Drawings showing dimensions and mounting arrangements of enclosures.
2. Elementary control wiring diagrams
3. Unit wiring diagrams for each motor controller
4. Nameplate nomenclature
5. Short circuit rating of complete motor controller assembly.
6. Motor List: Submit Owner's Representative complete listing of motors with following designations:

    a. Motor nameplate designation
    b. Horsepower, voltage, temperature rise and service factor.
    c. Full load current
    d. Fuse size or trip setting selected basis of selection
    e. Overload selected

PART 2 - PRODUCTS

2.1 BASIC REQUIREMENTS

A. Provide combination type individual motor controllers with disconnect switches and magnetic starters in common enclosure, or provide manual motor starters with overload protection. Provide all necessary control and pilot devices as required for satisfactory operation of equipment to be controlled.

B. Provide full or reduced voltage, non-reversing, reversing or multi-speed type starters as required by application.

C. Controllers with magnetic starters shall be rated for **[480] [208]** volt/3 phase/60Hz operation. Manual starters shall be rated for 120 volt/1 phase/60Hz operation unless otherwise noted.

D. Provide controllers with magnetic starters, with short circuit ratings as required by the Drawings or by actual available short circuit currents as indicated in the Fault Current and Coordination Study, whichever is greater.

2.2 CONTROLLER DISCONNECT SWITCH

A. Provide a horsepower rated disconnect switch as part of each individual combination magnetic motor controller. Each combination controllers shall have a heavy duty 3 pole single throw knife switch, with a quick make quick break mechanism suitable for motor full load operations.

B. Provide fused switches as noted on the drawings and required by Code and where multiple motor controllers are served by a common branch circuit or feeder. Fuse clips shall be rejection type suitable for current limiting fuses only.

2.3 ENCLOSURES

A. Individual motor controllers shall be mounted in NEMA Type 1A enclosures for typical indoor locations. Utilize NEMA Type 3R for outdoor locations and NEMA Type 4 for other wet locations or locations subject to water spray or very high humidity.

B. Provide enclosures for magnetic controllers with the following features:

1. Hinged cover with lock.

2. Interlock between switch and cover that prevents door opening with switch in "on" position. Also, provide a door interlock bypass feature that utilizes a special tool or procedure.

3. Capability to padlock switch handle in "on" or "off" positions.

4. Multiple knockouts in the sides and back (NEMA Type 1A enclosures only).

5. Ability to mount enclosure on wall or floor on angle iron frame.

2.4 STARTERS

A. Provide the following types of motor starters as required:

1. Provide 120 volt/1 phase manual starters for motors less than 1/2 Hp. Except where remote or automatic control is required. In such cases, provide FVNR magnetic starters. Provide manual starters with the following features:

   a. Toggle operated switch
   b. Switch handle lock off feature
   c. Long life pilot light
   d. Thermal overload protection with properly sized heaters
   e. A label engraved on nameplate or faceplate

2. Provide 480 or 208 volt/3 phase/60Hz as required, full voltage non-reversing (FVNR), and magnetic starters for motors of 1/2 Hp up to 100 Hp. Provide contactor with 120 volt coil and control power transformer unless otherwise required. Minimum starter size shall be NEMA 1.

3. Provide reduced voltage, non-reversing, autotransformer type, magnetic starters for motors 100 Hp and larger. Autotransformer shall be two winding, open delta connected type. Provide reduced voltage starters with the following features:

   a. Adjustable timing relay for start to run transfer timing.

   b. Closed transition from start to run motor connection

   c. 50%, 65% and 80% auto transformer taps; factory set at 50% and easily converted in the field to 65% or 80%.

   d. 120 volt coils on starting and running contactors unless otherwise required.

4. Provide special purpose starters for special applications or as required by Drawings (i.e. reversing or two speed starters, duplex starters, Wye-Delta starters, etc.)

2.5 CONTROLS AND PILOT DEVICES

A. Provide the following controls, pilot devices and features with each FVNR and reduced voltage magnetic starter:

1. Two winding control circuit transformer with sufficient volt-amp (VA) capacity to supply the in-rush and continuous power requirements of the starter coil(s) and the control circuit(s). Control transformer capacity shall be manufacturer's standard size. Minimum control transformer capacity shall be 50VA. Control transformer secondary shall be 120 volts unless otherwise required but in no case shall it exceed 120V. Provide dual element fuse in each line of the control transformer primary. Provide a single dual-element fuse in the ungrounded secondary lead. Engrave the required fuse size on the fuse block or adjacent thereto. Connect the control transformer primary to the motor branch circuit. Ground one terminal of secondary winding to enclosure.

2. Hand-Off-Automatic (HOA) maintained contact selector switch, unless otherwise required. Switch shall be built into cover.

3. Minimum of one green long life (50,000-hrs.) pilot lamp built into cover.

4. Minimum of four sets of Normally Open (N.O.) auxiliary contacts that are easily converted in the field to Normally Closed (N.C.) contacts.

5. Three phase, ambient temperature compensating, thermal overload relays with three properly selected heaters. Overload relays shall have a trip adjustment from at least 90% to 110% of heater rating. Trip setting shall be factory set at 100%. Provide push button on cover for manual reset of overload relays. Furnish overload relays set for manual reset operation, although they shall be capable of being easily converted in the field to automatic reset.

6. The holding coils for the starter contactors shall provide inherent undervoltage protection. Contactors shall open when control circuit voltage drops to approximately 60% of nominal. When required by Drawings or necessitated by circumstance, provide undervoltage reset push button on cover and set of auxiliary contacts to prevent automatic restart of motor.

7. Terminal strip for both remote and local connections.

8. Any additional controls and pilot devices required for proper operation of the installation.

9. Provide disconnect switch interlock where control power is from external source; de-energized control; circuit when disconnect switch is opened.

10. Applicable wiring diagram as approved on shop drawings pasted on inside of enclosure door.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR CONTROLLERS

A. Install individual motor controller on a nearby wall, within ten feet of motor to be controlled or adjacent to the motor or angle iron or uni-strut frame or as required by the Drawings. Do not mount on equipment or fan housings.

B. Perform all necessary field modifications and adjustments to each individual motor controller to provide required operation.

C. Coordinate installation with remote control devices and remote indicating devices for complete functional operation.

D. Overload Elements: Install properly rated elements in controllers

E. Wiring: Install incoming and outgoing power circuits.

F. Where variable speed drives are utilized, all outgoing power circuits shall be installed in individual conduits. No two circuits shall be in the same conduit.

G. Nameplates: Install equipment identification nameplates on exterior of doors with self-tapping screws.

H. Completed installation shall contain non-extraneous openings.

3.2 COORDINATION

A. Review Division 23 Contract Documents for required starter accessories, interlocks, etc. Failure to fully coordinate this item with the Division 23 Contractor shall in no way relieve this Division 26 Contractor from providing a complete, functional and coordinated system as described.

END OF SECTION 26 29 13

SECTION 26 32 13 - ENGINE GENERATOR(S) AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. It is the intent of this package to purchase a new 600kw/750kva generator with load bank and paralleling controls as indicated on the specifications and drawings. The generator is to be paralleled with the existing generator. Upgrades to the existing generator controls necessary to achieve paralleling are to be included in this project.

B. Related Sections include the following:

1. Section 26 23 13 – Pre-Purchased Paralleling Switchgear

1.2 STANDARDS

A. Except as modified by governing codes and the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. NEMA MG 1 - Motors and Generators
2. NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines
3. NFPA 99 - Health Care Facilities
4. ANSI/NFPA 70 - National Electrical Code
5. NFPA 110, Type 10, Level 1 – Emergency and Standby Power Systems
6. UL 142 – Fuel Tanks Double Wall
7. UL 2200
8. ISO 8528
9. International Building Code (IBC)
10. Seismic Certified 2018 Generator Set Assembly.
11. EPA Tier 2 Emission Standards for Compressed Ignition Engines
12. Noise Emission: Comply with applicable state (NJDEP) and local government requirements for maximum noise level at property boundaries due to sound emitted by the generator set, its components and the operation thereof.

1.3 SYSTEM DESCRIPTION

A. Engine generator system to provide source of emergency and standby power.

B. System Capacity: As shown on drawings at an elevation of 500 feet above sea level, and maximum ambient temperature of 109°F; standby rating using engine-mounted radiator.

C. Operation: In accordance with NFPA 110.

D. Generator set shall be capable of operating at 100% rating with no limitation on run hours or load factor during an emergency without impact on manufacturer's warranty.

1.4 SUBMIT WITH BID FOR TECHNICAL REVIEW

A. Provide two copies of the following documents with the bid to verify compliance. Documents shall be clearly marked indicating specific technical criteria specified, in red boxes. Adjacent to the red box indicate the spec section for ease in verifying compliance. One electronic copy shall be available upon request.

B. Generator set spec sheet indicating engine manufacturer, fuel consumption and dimensions.

C. IBC 2018 certification demonstrating operational capability given Sds 3.2g seismic conditions for a ground level installation.

D. Alternator data sheet verifying oversized, temperature rise (Class B 105C rise over 40C ambient), with minimum 8,350 skVA motor starting (at 0.4 power factor and max 30% instantaneous voltage dip), and max <12% subtransient reactance (X"d).

E. Starting system specification sheets detailing dual heavy-duty electric starters, 35 amp charging alternator, and minimum CCA and AH capacity of oversize batteries.

F. Battery disconnect switch details.

G. Extended Life Ethylene Glycol Coolant data sheet

H. Extended four (4) year warranty disclosure statement indicating compliance with terms and temporary generator allowance.

I. Warranty disclosure letter confirming the selling dealer is authorized to provide all warranty repairs without using third party service personnel or facilities.

1.5 SUBSTITUTION

A. Proposed deviations from the specifications shall be treated as follows:

1. Substitution Time Requirement: Requests for substitutions shall be made a minimum of ten (10) days prior to bid date. Manufacturers catalog data shall accompany each request and authorized acceptance shall be addenda only.

2. Substitution Responsibility: The power system has been designed to the specified manufacturer's electrical and physical characteristics. The equipment sizing, spacing, amounts, electrical wiring, ventilation equipment, fuel, and exhaust components have all been sized and designed around CATERPILLAR supplied equipment. Should any substitutions be made, the CONTRACTOR shall bear responsibility for the installation, coordination and operation of the system as well as any engineering and redesign costs, which may result from such substitutions. In addition, the design calls for an integrated, "on board" paralleling to the existing Caterpillar 400kW/500kVA unit currently at site.

1.6 SUBMITTALS

A. With each emergency power system acceptance package, the following is required. Submittals failing to meet these criteria will be returned without a review or acceptance.

1. Factory published specification sheet.

2. Manufacturer's catalog cut sheets of all auxiliary components such as battery charger, control panel, enclosure, etc. including cuts on the panel and circuit breaker used for “on board” paralleling, for the existing Caterpillar unit, at site.

3. Dimensional elevation and layout drawings of the generator set, enclosure and transfer switchgear and related accessories.

4. Weights of all equipment.

5. Concrete pad recommendation, layout and stub-up locations of electrical and fuel systems.

6. Complete detailed wiring diagram of the system, including generator remote radiator, cooling pumps, switchgear, battery charger, fuel system and remote alarm indications as the site specification dictates. These drawings shall be specific to the project component requirements and provided by the dealer. Factory drawings that provide multiple interconnections for items not specific to the project will be rejected.

7. Exhaust system calculations, in order to verify that the exhaust system, including the generator, remote radiator, cooling pumps, switchgear, battery charger, fuel system and remote alarm indications as the site specifications dictates. These drawings shall be specific to the project component requirements and provided by the dealer. Factory drawings that provide multiple interconnections for items not specific to the project will be rejected.

8. Submit certificates for compliance with EPA and NJDEP Emissions standard for compression Ignition Engines.

9. Engine and generator combination transient report at rated power factor for specific model supplied, of voltage and frequency transients’ response including recovery time at 50, 75 and 100% load application.

10. Submit manufacturer’s installation instructions under provisions of this and other sections.

11. Authorized distributor shall provide copies of technician's factory training certificates specific to the proposed product on engine overhaul and electrical systems control repair in order to verify the level of support capabilities. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications.

12. Engine mechanical data, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, fuel consumption, etc.

13. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.

14. Generator resistances, reactances and time constants.

15. Generator locked rotor motor starting curves.

16. Manufacturer's documentation showing maximum expected transient voltage and frequency dips, and recovery time during operation of the generator set at the specified site conditions with the specified loads.

17. Manufacturer's and dealer's written warranty.

1.7 PROJECT RECORD DOCUMENTS

A. Accurately record location of engine generator and mechanical and electrical connections.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions this and other sections.

B. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.9 QUALITY ASSURANCE

A. Seller and servicer shall have local representation and shall have been trained and approved in the assembly, installation and service of this equipment and warranty repair, for a period of not less than 25 years in the New Jersey area.

B. Equipment suppliers shall have full parts backup, be located within 50 miles of the project site and guarantee 4 hours emergency response time for technicians to arrive on project site at all times (365/24/7).

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The documents are based upon Caterpillar engine generator criteria where manufacturers are proposed other than Caterpillar the Contractor shall be responsible for modifications necessary in the use of a proposed manufacturer. These modifications are to include all mechanical and electrical work, architectural work and structural work.

B. The following manufacturers are approved:

1. Caterpillar
H.O. Penn Machinery Company, Inc.
20 Platinum Ct,
Medford, NY 11763
(516) 369-1771

2. Detroit Diesel
Atlantic Power Systems
Stewart & Stevenson Power Products, LLC
180 Rte. 17
South Lodi, NJ 07644
ATTN: Eric Lavin
(201) 678-8020

3. Cummins
Cummins Power Systems, LLC
435 Beyer Ave.
Kearny, NJ 07032
ATTN: Michael McKeon
(609) 306-8068

2.2 PACKAGED ENGINE-GENERATOR SET

A. There shall be no limitation on run hours during an outage.

B. Packaged engine-generator set shall be a coordinated assembly of compatible components.

C. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, model and serial number, and component rating in integrated set and as required by the contract documents.

D. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components. Provide a rigging diagram permanently attached to the mounting frame to indicate the capacity of each lifting attachment and the generator-set center of gravity.

E. Factory test shall be at .8 power factor and 100% load prior to shipment.

2.3 CRITERIA

A. The engine generator system shall comply with NFPA 110 requirements for a Type 10, Class 24, Level 1 system as a minimum.

B. The engine generator system and accessories described herein shall be fully capable of operation as specified in the following environmental conditions:

Maximum ambient temperature: 109 degrees Fahrenheit
Altitude: 500 feet above sea level

C. The generator set shall be capable of operating at 100% rating with no limitation on run hours or load factor during an emergency without impact on manufacturer's warranty.

2.4 ENGINE

A. The engine shall be diesel fueled, four (4) cycle, water-cooled, while operating with nominal speed not exceeding 1800 RPM. The engine will utilize in-cylinder combustion technology, as required, to meet applicable EPA non-road mobile regulations and/or the EPA NSPS rule for stationary reciprocating compression ignition engines. Additionally, the engine shall comply with the State Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with applicable EPA emissions standards per ISO 8178 – D2 Emissions Cycle at specified ekW / bHP rating. Emissions requirements / certifications of this package:

1. EPA ESE

B. Generator:

1. Rating: 750kw Standby,
2. Maximum Cylinders: 16
3. Minimum Displacement: 18.1 liters
4. Engine Speed: 1800 rpm
5. Max Fuel Consumption at 100% load: 42.7 gallons/hour

C. The prime mover shall be a liquid cooled, diesel fueled, turbo charged, after cooled engine of 4-cycle design. The unit requires an operating speed of 1800 RPM.

1. Engine shall meet the current EPA Tier 2 emissions.

D. The engine shall be equipped with an isochronous governor capable of electronic engine control, load sharing and speed sensing.

E. Engine safety devices shall provide engine shutdown on high water temperature, overspeed sensing, low oil pressure, and low water temperature, and engine overcrank. Limits as selected by manufacturer.

F. Engine wiring shall be high quality, heat resistant, insulated, stranded copper conductor. Wiring shall be protected with suitable woven loom protection and shall be isolated from high temperature engine parts. Wiring for alternating current power circuits shall be protected by rigid or flexible conduit.

2.5 ELECTRIC STARTING SYSTEM

A. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector on engine-generator control panel. Provide the following accessories:

B. Dual 24VDC electric starter motors

C. Batteries: 4X 12 Volt, maintenance free, wet batteries. Each battery rated at 12V, 1500CCA, 210 amp-hr. Provide with battery cables and acid resistant battery tray.

D. Battery-Charging Alternator: mounted on engine with solid state voltage regulation.

E. Battery Charger: current limiting type, 35 amp minimum, microprocessor controlled stationary AC/DC power supply battery charger with built in battery health assessment system and remote battery temperature sensor. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet IBC seismic certification, NFPA 99 and NFPA 110 (Level 1) requirements.

F. Include NFPA 110 Level I alarm.

2.6 ENGINE HEATING SYSTEM

A. Jacket water heaters shall be sized to maintain engine jacket water above 100 degrees F and suitable for operation at 208 or 240 Volt AC. Heaters shall include thermostats and required connection boxes. Heaters shall be rated 9 kw minimum each side of engine.

B. Jacket water heaters shall be factory installed complete with isolation valves, hoses, auto disconnect and complete wiring.

2.7 ENGINE COOLING SYSTEM

A. The generator set shall be equipped with a rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 122°F ambient air entering the enclosure. The system shall be capable of operating at a static pressure restriction of the enclosure. The generator supplier shall be responsible for a properly sized system.

B. Engine cooling design assures delivery of the rated generator performance (kW, transient response, emissions, etc.). No substitutes.

C. Twelve (12) flexible hoses shall be supplied loose for contractor installation as per manufacturer's recommendation for each generator.

D. The unit shall have a coolant drain line with valve; terminated on edge of base, fan and belt guards, coolant level sight gauge and a coolant level sensor that will connect to the control panel for annunciation of alarm. The engine shall have thermostats and housing, full open

temperature 92 deg C (198 deg F). with a jacket water pump, gear driven, centrifugal. The unit shall be ready ofr start up with Extended Life Coolant.

2.8 LUBRICATION SYSTEM

1. Engine or skid mounted filter and strainer, thermostatic control valve capable of full flow and designed to be fail safe, and crankcase drain arranged for gravity drainage with siphon or pump. Lube oil and pre-lube pump included.

2.9 AIR INTAKE AND EXHAUST SYSTEM

A. An air cleaner/silencer shall be furnished as recommended by the engine manufacturer. Air cleaners shall be single stage including service indicator and filter.

B. Engine exhaust outlets shall be coupled to the exhaust silencer(s) by means of an adequately sized section of stainless steel corrugated flex. Flex connector(s) shall be flanged at both ends for mating to the engine and exhaust system.

C. A critical grade exhaust silencer(s) shall be provided. Exhaust silencer(s) shall be sized to limit exhaust back pressure to 27 inches water column. The exhaust silencer(s), side inlet with muffler companion flanges and flexible exhaust fitting, shall be suitable for horizontal mounting. The exhaust silencer(s) shall be double wall construction and shall have a high temperature anti-corrosion coating applied uniformly on the outside surface.

2.10 ENGINE ACCESSORIES:

A. Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, primary fuel filter, fuel water separator, return fuel cooler, gear-driven water pump.

1. Crankcase ventilation system with fumes disposal plumbed to the engine.
2. Duplex fuel filter and water separator with the ability to swing and replace while the generator is in use.

B. Spring-type Vibration Isolators: comply with site location seismic requirements, integral seismic restraint and external adjustment for 1-inch deflection.

2.11 GENERATOR

A. The synchronous three phase generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling. The generator shall meet performance class G2 of ISO 8528. The excitation system shall enable the alternator to sustain 300% of rated current based on the 105C (Class F) rise rating for ten seconds during a fault condition and shall improve the immunity of the voltage regulator to non-linear distorting loads. The excitation system shall be of brushless construction and be independent of main stator windings (either permanent magnet or auxiliary windings).

B. Provide locked rotor motor starting capability of 1993.4 skVA at 30% instantaneous voltage dip as defined per NEMA MG 1. Sustained voltage dip data is not acceptable.

C. Integrated Voltage Regulator (IVR)

1. The IVR shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. The IVR shall be cable of configuring knee frequency and voltage regulation configurable up to +/-30%. The voltage regulator shall include a VAR/Pfcontrol feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic in order to optimize voltage and frequency response for site conditions. The IVR shall be capable of setpoint adjustment.
2. The existing unit shall also be upgraded to a new IVR to allow for matching cont4rols and ensure proper parallel operation.

2.12 CIRCUIT BREAKER

A. Provide a generator mounted, motorized circuit breaker, molded case, Qty. (1) 1200-amp trip, 3 pole, NEMA 1/IP22. Breaker shall utilize a solid-state L-S-I trip unit and include 2 form C contact and bell alarm rated at 24VDC. The breaker shall be UL Listed and connected to engine/generator safety shutdowns, as well as control for paralleling operation. Breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the generator set. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be supplied on the load side of breaker. All breakers shall be adjustable, and breaker shall be equipped with digital display.

B. A motorized breaker with the same capabilities must also be installed on the existing site genset and the current manual breaker removed. The breaker will also need to be wired for motorized control and alarms and indications to the new EMCP 4.4 control, as necessary, to make a fully functional paralleling system between the new and existing units.

2.13 CONTROLS AND INDICATION

A. Provide a fully solid-state, microprocessor based, generator set control for both the existing and new units, including local and remote annunciators. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls via SAE J1939.

B. Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator–set vibration.

C. The engine-generator set shall contain a complete 2-wire automatic engine start-stop control which starts the engine on closing contacts and stop the engine on closing contacts. A cyclic cranking limiter shall be provided to open the staring circuit after eight attempts if the engine has not started within that time. Engine control modules must be solid state plug-in type for

high reliability and easy service. The engine controls shall also include a 3-position digital selector with the following positions: OFF/ON/AUTO.

D. The following functionality shall be integral to the control panel.

1. The control shall include a minimum 5.5-inch, 480 x 320 pixel, white backlit graphical display with text based alarm/event descriptions.

2. The control shall include a minimum of 6-line data display

3. Generator set overview screen displaying critical generator set mechanical and electrical data on a single screen.

4. Audible horn for alarm and shutdown with horn silence switch

5. Standard ISO labeling

6. Multiple language capability

7. Remote start/stop control

8. Local run/off/auto control integral to system microprocessor

9. Cooldown timer

10. Speed adjust

11. Lamp test

12. Emergency stop push button

13. Voltage adjust

E. 12 digital inputs and 8 Form C outputs. 17 digital outputs, integral to the controller and capable of sourcing up to 200mA.

F. The panel shall allow the operator to create custom logic functions to provide additional user defined control of the generator set operation.

G. A generator run relay and common fault relay with dry contacts shall also be provided for customer use.

H. The controls shall provide the following digital readouts for the engine and generator. The module will store and display all pertinent unit parameters including.

1. Generator Status

a. Current unit status in real time

2. Instrumentation

   a. Available Data Points

      1) Oil pressure
      2) Coolant temperature
      3) DC battery voltage
      4) Engine RPM
      5) Twenty (20) event fault log
      6) Engine hours
      7) Engine successful start counter
      8) Engine crank attempt counter
      9) Service Maintenance Interval
      10) Fuel Consumption gal/hr
      11) Total Fuel Consumed
      12) Battery Volts
      13) Engine exhaust temperature (L & R)
      14) Engine oil temperature
      15) Fuel filter differential
      16) Fuel pressure
      17) Oil filter differential pressure
      18) Fuel pressure
      19) Oil filter differential pressure
      20) Oil temperature
      21) Generator bearing temperature
      22) Generator stator winding temperature

   b. Viewing of all Instrumentation Digital

      1) AC L-L voltages
      2) AC L-N voltages
      3) All AC Line Current
      4) Frequency

   c. Instrumentation Digital (Additional)

      1) Kw (total and per phase)
      2) Kva (total and per phase)
      3) kVAr (total and per phase)
      4) Power Factor (overall and per phase)
      5) kW hours
      6) KvarHours
      7) Kvars

3. Generator Commands

   a. Current engine start/stop status

4. Alarm Status: The control panel shall monitor and provide alarm indication and subsequent shutdown as noted below.

    a. Current alarm(s) condition
    b. Overcrank
    c. Low coolant temperature warning
    d. High coolant temperature warning / shutdown
    e. Low coolant warning / shutdown
    f. Low oil pressure warning / shutdown
    g. Overspeed
    h. Control switch not in auto
    i. High/Low battery voltage
    j. Emergency stop activated
    k. Over Under voltage
    l. Over Under frequency
    m. Reverse power
    n. Overcurrent
    o. Battery charger failure
    p. Low fuel pressure warning / shutdown
    q. High fuel pressure warning / shutdown
    r. Fuel filter restriction warning / shutdown
    s. Loss of excitation alarm/shutdown
    t. Instantaneous over excitation alarm/shutdown
    u. Time over excitation alarm/shutdown
    v. Rotating diode failure
    w. Loss of sensing
    x. Loss of PMG
    y. High intake manifold air temperature warning / shutdown

5. NFPA 110 Local Panel Annunciator, Level 1

2.14 REMOTE COMMUNICATIONS

A. The control shall include Modbus TCP communications via Ethernet 10BASE-T and Modbus RTU communications via RS-485 half duplex with configurable baud rates from 2.4k to 57.6k.

2.15 REMOTE MONITORING SOFTWARE

A. The control shall provide Monitoring Software with the following functionality

1. Monitor up to eight (8) generator sets, plus ATS and UPS.
2. Provide access to all date and events on generator set communications network.
3. Provide remote control capability for the generator set(s).
4. Ability to communicate via Modbus TCP, Modbus RTU or remote modem.

2.16 ACCESSORIES

A. Radiator mounted load bank: minimum 50% generator rating. Remote controls mounted at either generator or remote switchgear. Select at least five load levels (kW) from 0-100%. Automatic load dump capability should generator be required for emergency power.

B. Remote Manual Stop Station (Emergency Power Off EPO): Provide a remote manual stop station with weatherproof stainless steel or die cast housing, red mushroom button - push to stop operation, breakable cover/lens to access mushroom button, 120 volt rated. The manufacturer shall provide automatic monitoring of the EPO switch. Placing the EPO switch in the "Generator Powered OFF" status shall initiate a visual and audible alarm at each generator annunciator panel for each location listed.

1. Location to be determined

C. Remote Engine Annunciator Panel: ANSI/NFPA 99 and NFPA 110 for a Level 1 system. Include the listed pre-alarm and alarm points, audible alarm, alarm silencing means, repetitive alarm circuitry, and lamp test switch in a flush mounted panel with brushed stainless-steel finish. Provide all interconnecting wiring in conduit per manufacturer's requirements by the Electrical Contractor. Annunciator panel shall be able to communicate up to 2000'. The remote annunciator(s) shall be mounted in the following locations:

1. Provide three (3) panels per generator set. One (1) in the emergency department, another in the Fire Command Center, and the remaining to be furnished as part the generator control panel. Provide alarm indicators per NFPA 110 (Level 1) and as specified herein. When actuated, these alarms shall sound audible alarms and indicate, by means of individual light at annunciator panels, which particular malfunction is initiating the alarm. Provide 3/16-inch high (minimum) labeling to identify the alarm. The remotely reported alarms shall include the following.

    a. Overcrank
    b. Low water (engine) temperature
    c. High engine temperature pre-alarm and high engine temperature
    d. Low lube oil pressure pre-alarm and low lube oil pressure
    e. Overspeed
    f. Low fuel main tank
    g. Low coolant level
    h. Not in auto
    i. Emergency Power Supply (EPS) supplying load
    j. High battery voltage
    k. Low battery voltage
    l. Battery charger failure (includes AC failure)
    m. Generator running
    n. Normal utility power
    o. Emergency stop and Emergency Power Off Switch activated (EPO).
    p. Spare (or ATS Remote Start wiring failure)
    q. Spare (or Tier 4 SCR when applicable)

D. A load bank shall be provided integral to each generator. The load bank shall be a resistive load rated at 50% of generator kw. The load bank shall be capable of adding load in increments of 50kW.

2.17 SEQUENCE OF OPERATION

A. Description: This sequence describes a system utilizing CAT® EMCP4.4 generator controllers to parallel the new and existing generators to each other in an island or standby application.

1. Functional Sequence of Operation

a. The EPS Automation shall be provided with the following Modes of Operation:

1) Automatic/Standby Mode

a) The automatic transfer switches are in the normal position serving utility power to the loads.
b) The generator set main breakers are open.
c) The automation is standing by to act in response to a run request from associated automatic transfer switches.

2) Emergency Mode

Entry

a) Automatic Transfer Switch Run Request is received by all generator controllers
b) Where applicable, load shed sequence is executed.
c) All available generators are started.
d) The first generator up to voltage and frequency is closed to the bus.
e) Critical loads and load shed priority 1 loads are powered.
f) The remaining generator sets are synchronized and paralleled to the bus as they come up to voltage and frequency.
g) As additional generators are paralleled to the emergency bus, Load Shed Priority levels are added, powering their associated loads.
h) The system will continuously monitor real and reactive power and proportionally share load among all generators on the bus.
i) The system is now in emergency mode.

Exit

a) Automatic transfer switches sense the utility source is within acceptable operational tolerances for a time duration set at the automatic transfer switch.
b) As each automatic transfer switch transfers back to utility power, it removes it’s run request from the generator plant.
c) When the last automatic transfer switch has retransferred to the utility and all run requests have been removed from the generator plant, the tie breaker (if present) and all generator set main circuit breakers shall be opened.

d) The generator sets are allowed to run for their programmed cool down period and shut down.
e) The system is returned to automatic/standby mode

2. Load Sense Generator Demand

a. The controller shall also include logic to automatically sequence the generator sets based on the total load requirement of the system. If the load exceeds a minimum reserve kW threshold, additional generator sets will automatically start, synchronize, and close the generator circuit breaker. If the site load falls below a reserve kW threshold, a generator set will automatically unload, open the generator circuit breaker, and shutdown.

2.18 DOUBLE-WALL SUB-BASE FUEL TANK(s)

A. Provide above ground, rectangular, secondary containment fuel tank(s) mounted directly to the bottom of the generator (sub-base) or within the skid perimeter (in base). Both the inner and outer tanks shall be UL listed and have emergency relief vent openings. The inner tank shall be sealed inside the outer tank. The outer tank contains the fuel only if the inner tank ruptures or leaks.

B. The double wall, sub-base fuel tank shall have the following features:

1. Fuel supply and return openings.
2. Emergency pressure relief opening.
3. Heavy gauge steel construction.
4. Integral stub-up area.
5. Fuel fill opening – 2" N.P.T.
6. Removable end for access to stub-ups.
7. Lockable fill caps and riser kit.
8. Low fuel level alarm kit.
9. Mechanical fuel gauge.
10. Normal vent with riser and mushroom cap.
11. Basin drain.
12. Spring isolators.
13. U.L. listed.
14. Emergency pressure relief vent opening – inner tank.
15. Inner tank leak alarm kit.
16. Electronic control day tank kit with 120-volt transfer pump and controls. Note: Provide this item only if required by the manufacturer as necessary for the generator engine to receive fuel from the sub-base tank.

C. Fuel tanks shall have enough capacity to operate the generators for 24 hours with 133% capacity and rupture basin capable of 110% in accordance with NFPA 110. The tank shall meet UL142 standards. A locking cap, a mechanical reading fuel level gauge, low level alarm contact, and fuel tank rupture alarm contact shall be provided. The robust base design includes linear vibration isolators between tank base and engine generator.

2.19 GENERATOR ENCLOSURE

A. Attenuated Enclosure (Standard Sound optional)

1. The complete engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, sound attenuated enclosure mounted on the fuel tank base.

a. A weather resistant, sound attenuated enclosure of steel with electrostatically applied powder coated baked polyester paint. The enclosure shall have a resulting sound level of 75 dba @ 23 ft at an ambient capability of 109 F, with the genset running under full load. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.

b. Enclosure Sound Attenuation: Acoustical foam shall be provided between all supports and inside doors and sound baffles on air intake and air discharge.

B. Paint: The enclosure panels shall have the exterior finish painted using the powder coat process. Final color of finish coat will be selected at shop drawing review.

PART 3 - EXECUTION

3.1 GENERAL

A. Accept packaged engine generator set and accessories on site and verify any damage.

B. Protect equipment from dirt and moisture by securely wrapping in heavy plastic as required.

C. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions.

D. Installation equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The engine generator set shall be installed on a concrete pad. The engine generator set shall be permanently fastened to the pad in accordance with the manufacturer's instructions and seismic requirements of the site. Vibration isolation shall be provided through the use of spring isolators.

E. The on-site power system shall be initially started and operated by a representative of the manufacturer and EGSA (Electrical Generating Systems Association) Certified Technician.

F. All equipment shall be inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

3.2 VIBRATION ISOLATION

A. Isolate the generator set at the base by means of combination spring type isolators and neoprene pads. Provide isolators of not less than 98 percent efficiency of a sufficient quantity such that each is loaded to not more than 75 percent of its rated value.

B. All fuel oil and coolant lines shall be isolated by means of flexible braided bronze hoses.

C. All raceway connections to set shall be in flexible metal conduit.

3.3 WARRANTY

A. The standby electric engine-generator and instrumentation panel from the factory shall be warranted against defective materials and factory workmanship for a period of two (2) years with a max 2000-hour term.

B. The Extended Coverage Service shall be provided for an additional period of five (5) years and 2500 hours and shall include no deductible. Extended Coverage Service shall provide for 100 percent of usual and customary parts, labor for failures due to defects in materials and workmanship to the as shipped consist from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches.

C. Extended Service Coverage provides rental power unit (minimum 2000 kW) due to unscheduled failures causing unexpected downtime to the customer in excess of 48 hours from the time of diagnoses.

D. All startup, troubleshooting and warranty repairs will be performed by factory trained service personnel employed by the seller. No exceptions. This shall allow for travel and mileage for all work.

E. Seller shall provide proof of ownership of minimum 10 rental generators (minimum 2000 kW each) to demonstrate means and capability to provide a rental if needed.

3.4 EXTRA MATERIALS

A. Provide five (5) extra DC incandescent lamps and five (5) compact fluorescent lamps if provided.

3.5 START-UP AND WARRANTY VALIDATION

A. The complete installation shall be tested for compliance with the specification following completion of all site work. All start-up procedures and testing of engine generator set, and automatic transfer switch will be performed by an authorized service center of the manufacturer. The fuel required for test purposes shall be provided by the contractor.

B. The following start-up procedures shall be performed by the manufacturers authorized service center, factory trained technician and EGSA (Electrical Generating Systems Association) Certified Technician.

1. Verification of fluid levels (coolant, lubricating oil, battery electrolyte, fuel)
2. Inspection to identify any loose or broken equipment
3. Verification of proper jacket water heater operation
4. Verification of proper battery charger operation
5. Static verification of control panel alarms and shutdowns
6. Exhaust system inspection to verify proper installation including rain cap
7. Verification of manual starting from local control panel
8. Verification that no fluid leaks exist
9. Verification of proper control panel gauge operation
10. Perform any necessary adjustments (output voltage, engine speed)
11. Verification of proper interface with the Automatic Transfer Switch(s)
12. Verification that the remote annunciator panel is operating properly.

C. For the existing unit, the ugrade to the EMCP 4.4 control panel and addition of the motorized breaker should be performed after acceptance of the new unit. This unit shall be test run without load to verify operation of the new panel and breaker performing the following checks:

1. Verify that the equipment is installed properly.
2. Check genset for general operation
3. Check safeties and alarms.
4. Check all auxiliary devices for proper operation, including voltage regulator, motorized circuit breaker, remote annunciator, etc.

D. After satisfactory performance of the genset operation as a standalone, the units should be tested with the new unit to demonstrate paralleling capability and function.

E. With resistive Load bank: Perform a 4-hour load bank test at a 1.0 PF at full nameplate rating for some time at the combined system of 800kW. Vary load to demonstrate load sharing and demonstrate any required features of the sequence of operation section. Load bank, cables and other equipment required for this test to be supplied by the genset supplier. Other tests shall be performed as described in this section.

3.6 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of specifications and in compliance with NFPA 110 requirements.

B. Provide portable test bank for full load test. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal.

C. Fill fuel tank prior to start of test (fuel provided by customer).

D. Six separate tests, including Cold/No. Load: Building Load, Full Load, Load Shedding, Sound and Infrared shall be performed as noted below:

1. Cold / No Load Test

   a. Generator #1 (600kw/750kva)

      The generator shall be started and brought up to speed and run for no less than 1 hour. During that time, check and note all gauges (oil pressure, water temperature, battery charge rate, voltage and frequency) on 15-minute intervals. Correct any deficiencies that may occur. If an error or alarm occurs during this time, make necessary corrects and re-run entire test.

      With no load on the generator, the governor shall be set to the manufacturer's recommended engine speed.

   b. Generator #2 (Existing)

      The generator shall be started and brought up to speed and run for no less than 1 hour. During that time, check and note all gauges (oil pressure, water temperature, battery charge rate, voltage and frequency) on 15-minute intervals. Correct any deficiencies that may occur. If an error or alarm occurs during this time, make necessary corrects and re-run entire test.

      With no load on the generator, the governor shall be set to the manufacturer's recommended engine speed.

2. Building Load Test

   a. Paralleled Generators

      Both generators #1 and #2 shall be started, brought up to speed and paralleled together via the paralleling gear. The actual building load, or load bank equal to that of the actual building load, shall be applied to the generators for no less than 1 ½ hours. Check and note all gauges and meters and note the following in accordance with NFPA:

      1) The time delay on start shall be noted.
      2) The cranking time until the prime mover starts shall be noted.
      3) The time taken to reach operating speed shall be noted.
      4) The voltage, frequency and amperage shall be recorded initially and at 15 min. intervals.
      5) The oil pressure and water temperature shall be recorded initially and at 15 min intervals.
      6) Generator overall run time for entire test.
      7) Time delay on retransfer to normal power shall be noted.
      8) Time delay of generator cool down period and shutdown shall be recorded.

3. Full Load Test

   a. Paralleled Generators

Both generators #1 and #2 shall be started, brought up to speed and paralleled together via the paralleling gear. Rated (or full) load, either through a load bank or combination of a load bank and actual building load, shall be applied to the generators as follows:

1) 30 minutes for no less than 30% of rated load
2) 30 minutes for no less than 50% of rated load
3) 60 minutes for no less than 100% of rated (or full) load

b. Rated or full load is defined as 100% of the combined nameplate rating of the generators. This is commonly referred to as 2-hour full load test. Check and note all gauges and meters and note the following in accordance with NFPA:

1) The time delay on start shall be noted.
2) The cranking time until the prime mover starts shall be noted.
3) The time taken to reach operating speed shall be noted.
4) The voltage, frequency and amperage shall be recorded initially and at 15 min. intervals.
5) The oil pressure and water temperature shall be recorded initially and at 15 min intervals.
6) Generator overall run time for entire test.
7) Time delay on retransfer to normal power shall be noted.
8) Time delay of generator cool down period and shutdown shall be recorded.

c. After conclusion of full load test, perform infrared test as noted in item 6 below.

4. Load Shed Test

a. Paralleled Generators

b. Both generators #1 and #2 shall be started, brought up to speed and paralleled together via the paralleling gear. 80% of rated (or full) load, via a load bank, shall be applied to the generator for 30 minutes. At that time, one of the generators shall be manually disconnected from the bus to activate the load shedding sequence. The remaining running generator will go into overload which will in-turn automatically remove Priority 2 transfer switch from the bus.

1) Time delay for load shedding sequence operation shall be recorded.

5. Sound Test

a. Both generators #1 and #2 shall be started, brought up to speed and paralleled together via the paralleling gear. 80% of rated (or full) load, via a load bank, shall be applied to the generator for 30 minutes. This test may be performed during load shed text.

1) dB sound level at 3ft. from generator (all angles) shall be recorded.

6. Infrared Test

a. After conclusion of full load test, perform infrared testing of entire newly installed electrical distribution system including all ATS, generator and related control. Remake any connections showing abnormally high temperature variations as required.

3.7 MANUFACTURER'S FIELD SERVICES

A. Prepare, start, test, and adjust systems per this and other sections.

3.8 ADJUSTING

A. Adjust generator output voltage and engine speed.

3.9 CLEANING

A. Clean work under provisions of this and other sections.

B. Clean engine and generator surfaces.

3.10 DEMONSTRATION

A. Simulate power outrage by interrupting normal source and demonstrate that system operates to provide emergency and standby power.

B. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. Training shall be coordinated with the facility Owner.

C. Provide all necessary wiring and conduit to each remote alarm panel.

3.11 TRAINING

A. The supplier of the electric generating plant and associated items covered herein shall provide factory trained field service engineer to provide a comprehensive training of site personnel for a minimum of 4 hours. Review operation and maintenance manuals, parts manuals, and emergency procedures.

END OF SECTION 26 32 13

SECTION 26 36 24 - AUTOMATIC TRANSFER SWITCHES WITH BYPASS-ISOLATION SWITCH

PART 1 - GENERAL

1.1 SUMMARY

A. General

1. Furnish and install closed transaction automatic transfer and bypass-isolation switch (ATS/BPS) system(s) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All automatic transfer and bypass-isolation switches and controllers shall be the products of the same manufacturer.

2. The closed transition automatic transfer switches shall be capable of full JHACO monitoring and contain engine start circuit monitoring.

1.2 CODES AND STANDARDS

A. Except as modified by governing codes and the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. UL 1008 – Standard for Transfer Switch Equipment

2. IEC 947-6-1 Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment

3. NFPA 70 – National Electrical Code

4. NFPA 99 – Essential Electrical Systems for Health Care Facilities

5. NFPA 110 – Emergency and Standby Power Systems

6. IEEE Standard 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

7. NEMA Standard ICS10-1993 (formerly ICS2-447) – AC Automatic Transfer Switches

8. UL 508 Industrial Control Equipment

1.3 SUBMITTALS

A. With each automatic transfer switch power system acceptance package, the following is required. Submittals failing to meet this criteria will be returned without a review or acceptance.

1. Manufacturer's catalog cut sheets, performance data, detailed drawings which relate to the design criteria specified.

2. Complete detailed wiring diagram of the system including all remote connections.

1.4 QUALITY ASSURANCE

A. Equipment suppliers shall have local representation and shall have been actively engaged in the assembly, installation and service of this equipment for emergency power purposes for a period of not less than 10 years in the job site area.

B. Equipment suppliers shall have full parts backup and a 24 hour per day service availability for this equipment.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Automatic Switch Co. (ASCO)

2.2 MECHANICALLY HELD TRANSFER SWITCH

A. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.

B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commality of parts.

C. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

D. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.

G. The neutral conductors are to be solidly connected and a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.3 BYPASS-ISOLATION SWITCH

A. A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.

B. Power interconnections shall be silver-plated copper bus bar. The only field installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control interwiring shall be provided with disconnect plugs.

C. Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door. Designs requiring insertion of loose operating handles or opening of the enclosure door to operate are not acceptable.

D. Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). Designs which disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.

E. The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.

F. When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.

G. Designs requiring operation of key interlocks for bypass isolation or ATSs which cannot be completely withdrawn when isolated are not acceptable.

2.4 MICROPROCESSOR CONTROLLER

A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.

B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to _ 1% of nominal voltage. Frequency sensing shall be accurate to _ 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

D. All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. IEEE472 (ANSI C37.90A) Ring Wave Test
2. ENC55011 1991 Class A Conducted and Radiated Emission
3. EN61000-4-2 Electrostatic Discharge Immunity, Direct Contact & Air Discharge
4. EN61000-4-3 Radiated Electromagnetic Field Immunity
5. EN61000-4-4 Electrical Fast Transient Immunity
6. EN61000-4-5 Surge Immunity
7. ENV50141 HF Conducted Disturbances Immunity
8. ENG1000-4-11: Voltage Dips Interruptions and Variations Immunity
9. M.1. Std. 461 Class 3C Group 1 Test UM05-Radiated and Conducted Electromatic Emissions.

2.5 ENCLOSURE

A. The ATS/BPS shall be furnished in a NEMA type 1 enclosure unless otherwise shown on the plans.

B. All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing and replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.

C. Nameplate

1. Provide a name plate of red bakelite with white lettering containing the following information.

ATS # _____ (1/2" Lettering)

Serves Panel _____ (1/4" Lettering)

Normal Power from Panel _____ CKT _____ (1/4" Lettering)

Emergency Power from Panel _____ CKT _____ (1/4" Lettering)

2.6 CONTROLLER KEYPAD AND DISPLAY

A. A four-line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

1. Nominal line voltage and frequency
2. Single or three phase sensing
3. Operating parameter protection
4. Transfer operating mode configuration (open transition, closed transition or delayed transition)

B. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.7 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

A. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):

B.

Parameter	Sources	Dropout / Trip	Pickup / Reset
Under Voltage	N & E, 3_	70% to 98%	85% to 100%
Over Voltage	N & E, 3_	102% to 115%	2% below trip
Under Frequency	N & E	85% to 98%	90% to 100%
Over Frequency	N & E	102% to 110%	2% below trip
Voltage Unbalance	N & E	5% to 20%	1% below dropout

C. Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20° C to 60° C.

D. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

E. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

2.8 TIME DELAYS

A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.

C. Two-time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minutes time delay in any of the following modes:

1. Prior to transfer only
2. Prior to and after transfer
3. Normal to emergency only
4. Emergency to normal only
5. Normal to emergency and emergency to normal
6. All transfer conditions or only when both sources are available

F. The controller shall also include the following built-in time delays for optional Closed Transition and Delayed Transition operation:

1. 1 to 5 minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.

2. 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.

3. 0 to 5 minutes time delay for the load disconnect position for delayed transition operation.

G. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

H. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

2.9 ADDITIONAL FEATURES

A. A three-position momentary-type test switch shall be provided for the test / automatic / reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.

B. A set of DPDT gold-flashed contacts rated 10 amps, 32 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

C. Auxiliary contacts rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source. Provide two (2) sets.

D. LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

E. LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

The following features shall be built-in to the controller, but capable of being activated through key pad programming or the serial port only when required by the user:

F. Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

G. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

H. An in-phase monitor with by-pass switch shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO Feature 27.

I. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

J. Engine Exerciser – The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:

1. Enable or disable the routine.
2. Enable or disable transfer of the load during routine.

3. Set the start time:

   - time of day
   - day of week
   - week of month (1st, 2nd, 3rd, 4th, alternate or every)

4. Set the duration of the run.

   At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

K. System Status – The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example;

- Normal Failed
- Load to Normal
- TD Normal to Emergency
- 2min15s

Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in the operator's manual, are not permissible.

L. Self Diagnostics – The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

M. Communications Interface – The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

N. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:

1. Event Logging

   a. Data and time and reason for transfer normal to emergency
   b. Data and time and reason for transfer emergency to normal
   c. Data and time and reason for engine start
   d. Data and time engine stopped
   e. Data and time emergency source available
   f. Data and time emergency source not available

2. Statistical Data

a. Total number of transfers
b. Total number of transfers due to source failure
c. Total number of days controller is energized

O. Communications Module – A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices. The serial communication interface shall be equal to ASCO Accessory 72A

P. Elevator Interface – Transfer switches which feed elevators or panels which serve elevators, shall have two (2) sets of contacts which shall communicate with the respective elevator controller. The first contact shall be closed when the transfer switch is on normal power. When the transfer switch goes to emergency power, the contacts open. The second contact shall have a 20 second timer for a pre-transfer back to normal power or a planned transfer to emergency power. This contact shall be normally open on normal power. Provide two (2) wires from each contact to the respective elevator controller. Coordinate this item with the elevator provider.

2.10 WITHSTAND AND CLOSING RATINGS

A. The ATS/BPS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS/BPS terminals with the type of overcurrent protection shown on the plans.

B. The ATS/BPS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1 1/2 and 3 cycle, long-time ratings. ATS/BPSs which are not tested and labeled with 1 1/2 and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

2.11 TESTS AND CERTIFICATION

A. The complete ATS/BPS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

C. The ATS/BPS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation, and servicing in accordance with ISO 9001.

2.12 SERVICE REPRESENTATION

A. The ATS/BPS manufacturer shall maintain a national service organization of company-employed personnel located throughout the continuous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

PART 3 - EXECUTION

3.1 GENERAL

A. Install the automatic transfer switches as shown on the drawings, in conjunction with the engine generator system as indicated in the manufacturer's instructions and as required for a neat workmanlike and fully operational system.

3.2 Provide in conjunction with each and every automatic transfer switch the following:

A. 2 #12-3/4" C. from engine start contact on transfer switch to respective emergency generator start circuit.

B. Wiring as necessary from transfer switch to remote annunciator panels and engine controller for transfer switch position indicator lights.

3.3 Provide necessary wiring from the elevator contacts to the respective elevator.

3.4 Provide all necessary wiring and conduit to each remote alarm panel.

3.5 Provide communication wiring between the transfer switch and the Building Management System.

3.6 The transfer switches shall be equipped with lugs as required to accept cables entering the enclosure from the top.

3.7 Run all power and control wiring in conduit.

3.8 Provide wiring diagrams showing all power, control and alarm wiring associated with the transfer switch(s), Building Management System, annunciator panel(s), paralleling switchgear or any other devices connected with the Emergency Power System.

3.9 INSTRUCTIONS

A. Manufacturer's approved operating instructions shall be permanently secured to cabinet where operator can see them. One-line and elementary or schematic diagram shall be permanently secured to inside of front enclosure door. Submit (6) (___) copies of operating and (6) (____) copies of maintenance manuals listing routine maintenance, possible breakdowns, repairs, and troubleshooting guide.

3.10 SITE TESTING

NOTE: Design should incorporate ATS testing in overall test of complete emergency system under load, including ATS and generators.

A. Following completion of ATS installation and after making proper adjustments and settings, site tests shall be performed in accordance with manufacturer's written instructions to demonstrate that each ATS functions satisfactorily and as specified. Advise Contracting Officer not less than 5 working days prior to scheduled date for site testing, and provide certified field test reports within 2 calendar weeks following successful completion of site tests performed. Minimum operational tests shall include the following:

1. Insulations Resistance

    a. Insulation resistance shall be tested, both phase to phase and phase to ground.

2. Power Failure of Normal Source

    a. Power failure of normal source shall be simulated by opening upstream protective device. This test shall be performed a minimum of five times.

3. Power Failure of Emergency Source

    a. Power failure of emergency source with normal source available shall be simulated by opening upstream protective device for emergency source. This test shall be performed a minimum of five times.

4. Low Phase to Ground Voltage

    a. Simulate low phase to ground voltage for each phase of normal source.

5. Operation and Settings

    a. Verify operation and settings for specified ATS features, such as override time delay, transfer time delay, return time delay, engine shutdown time delay, exerciser, auxiliary contacts, and supplemental features.

6. ATS and BP/IS Functions

    a. Verify manual and automatic ATS and BP/IS Functions.

END OF SECTION 26 36 24

SECTION 26 43 13 - TRANSIENT VOLTAGE SUPPRESSION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Contractor shall furnish all labor, materials, equipment and services necessary for and incidental to the installation of the Transient Voltage Surge Suppression (TVSS) System Components as specified herein.

B. Related Work Specified in Division 26

1. Section 26 24 13 – Switchboards
2. Section 26 24 16 – Panelboards

C. TVSS shall be provided on main service equipment, panels serving sensitive equipment, and all emergency panels.

1.2 STANDARDS

A. The transient voltage suppression units (also referred to as surge protective devices – SPD's) shall be manufactured and tested according to the latest applicable standards of the following agencies:

1. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits

2. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

3. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits

4. FIPS Pub 94 (1983) - Guide on Electrical Power for ADP Installation

5. 2005 National Electric Code (NEC)- Article 285

6. National Fire Protection Association - NFPA-20, NFPA-70, NFPA-75, NFPA-78

7. UL 1283 - Electromagnetic Interference Filters

8. UL 1449 Second Edition Revision Effective February 9, 2007 - Transient Voltage Surge Suppressors

1.3 SUBMITTALS

A. Refer to Section 26 05 05 concerning the procedures and additional documents for submittals in concert with transient voltage surge suppression submittals. Submittals failing to meet the following criteria will be returned without a review or acceptance.

B. Only firms that have been regularly engaged in the manufacture of transient voltage surge suppressors of the types and ratings required and whose products have been in satisfactory use in similar service are accepted. Upon request, suppliers/manufacturers shall provide a list of not less than three customer references that will prove the product has operated satisfactorily for a minimum of three years.

C. Submittals shall contain the required published data specifications and drawings to show conformance with all portions of this specification.

D. Instructions for installation and connection shall be provided with the suppression unit(s).

1.4 QUALITY ASSURANCE

A. Engage a firm with at least 5 years experience in manufacturing transient voltage surge suppressors.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Siemens Energy and Automation, Inc.
2. Raycap Corporation
3. Leviton
4. Or approved equal

2.2 SURGE SUPPRESSOR (SURGE PROTECTIVE DEVICE – SPD)

A. The surge suppressor shall be as follows:

1. SPD shall be UL 1449 Second Edition Revision Effective February 9, 2007 tested and listed to 200kA Short Circuit Current Rating (SCCR) in compliance with NEC 285.6.

2. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

3. SPD for service entrance applications shall be modular in design. Each mode including N-G shall be fused with a 200kAIR UL recognized surge rated fuse and incorporate a thermal cutout device.

4. Service entrance SPD shall provide audible diagnostic monitoring by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided.

5. If a dedicated breaker for the SPD is not provided in the switchboard, the service entrance SPD shall include an integral UL Recognized disconnect switch. A dedicated breaker shall serve as a means of disconnect for distribution SPD's.

6. SPD shall meet or exceed the following criteria:

   a. Minimum surge current capability (single pulse rated) per phase shall be:

      1) Service entrance applications: 240kA per phase
      2) Distribution applications: 80kA per phase

   b. UL 1449 Listed Suppression Voltage Ratings for service entrance shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	MCOV
208Y/120V	400V	400V	400V	150V
480Y/277V	700V	700V	700V	320V

   (With service entrance Internal Disconnect Switch 400V and 700V respectively.)

   c. UL 1449 Listed Suppression Voltage Ratings for distribution shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	MCOV
208Y/120V	330V	330V	330V	150V
480Y/277V	700V	700V	700V	320V

7. SPD shall have a minimum EMI/RFI filtering of –50dB at 100kHz with an insertion ratio of 50:1 using MIL-STD-220B methodology.

8. SPD shall be provided with one set of NO/NC dry contacts.

9. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period.

2.3 DISTRIBUTION PANELBOARDS

A. One suppressor shall be installed external to each designated distribution panelboard.

B. The surge suppression device shall be installed in accordance with manufacturer instructions.

C. The SPD shall be similar to Siemens TPS11080 for distribution.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Verify the proper application of the TVSS (i.e., voltage, phases, etc.). Coordinate with upstream and downstream transient suppression.

2. Install transient voltage surge suppressors as indicated in manufacturer's installation instructions and in accordance with the applicable portions of NEC and in accordance with recognized industry practices to ensure that product complies with requirements. NEC, State and Local Codes with prevail.

3. Assure the TVSS is connected to a ground system having measured DC resistance of 5 ohm maximum.

4. Install units plumb, level and rigid without distortion.

B. Coordination

1. Coordinate with other electrical work as necessary to interface installation of the transient voltage surge suppression systems work with other work.

3.2 ADJUSTMENTS AND CLEANING

A. Remove debris from SPD and wipe dust and dirt from all components.

B. Repaint marred and scratched surfaces with touch up paint to match original finish.

3.3 TESTING

A. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacture’s recommendations.

B. Check all installed panels for proper grounding, fastening and alignment.

3.4 WARRANTY

A. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

END OF SECTION 26 43 13

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: Provide luminaires and accessories in accordance with the Contract Documents.

B. Related Work Specified in Division 26

1. Section 26 05 10 – Testing, Inspection and Certification
2. Section 26 05 14 – Equipment Connections and Coordination
3. Section 26 05 21 – Wires and Cables
4. Section 26 05 29 – Hangers and Supports for Electrical Systems
5. Section 26 05 33 – Raceways and Boxes
6. Section 26 05 53 – Identification for Electrical Systems
7. Section 26 09 15 – Relays and Remote-Control Switches
8. Section 26 27 26 – Wiring Devices

C. Related Work Specified in Other Divisions of these Specifications.

1. F.F. & E. Package
2. Concrete Bases
3. Duct and Duct Accessories

1.2 STANDARDS

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Luminaires – UL 57, UL 1570, UL 1571, UL 1572, UL 676.

2. Exit and Egress Luminaires – NFPA 70 and 101, UL 924.

3. Hazardous Locations – UL 1225, UL 1203, UL 506, UL 844, UL 886.

4. IES-SPI-NEMA Joint Standards for Class A and Class C acrylic compounds for plastic enclosures.

5. L.E.D. Light Sources – UL 8750-09

6. Local code requirements.

1.3 SUBMITTALS

A. Submit shop drawings and manufacturers' data for the following items in accordance with the conditions of the contract and as specified below.

1. Major luminaires and special luminaires shall show full-size cross sections. Indicate finished dimensions, metal thicknesses, and materials.

2. Show mounting details, including hung ceiling construction.

3. For each fixture indicate type of driver and manufacturer and driver quantity. Include information as to power factor, input watts, and lumen output.

4. Indicate lamps to be utilized and quantity and submit photometry. Where the lamps to be utilized are other than ones which published photometric data is available for, additional test data shall be submitted to the engineer. These tests shall be performed by a certified independent testing laboratory or equal as approved.

5. Shop drawings shall include a complete listing of all luminaires on a single sheet. This listing shall contain the luminaire type, manufacturers catalog number, applied voltage and lamps.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Luminaires

1. Acceptable manufacturers are listed in the lighting fixture schedule shown on the Drawings. Acceptable lighting manufacture representatives are as follows:

   a. Penn Lighting Associates- - Contact: Barb Petrilla 570-926-7815
   b. Diversified Lighting Associates – Contact: Joe Rounsaville 484-225-7954
   c. Illuminations, Inc. – Contact: Tom Herron 610-704-7571
   d. Lighting Solutions, Inc. – Contact Joe Zangardi 570-550-4714
   e. Suppliers whose fixtures are specified in the Lighting Fixture Schedule.

2. Fixtures shall be as per specified in the lighting fixture schedule as shown on the Drawings. Substitutions to specified fixtures shall be made 10 days prior to bid due date for prior approval.

3. The designations indicated on the lighting fixture schedule are a design series reference (not necessarily a complete catalog number) and do not necessarily represent the number, size, voltage, wattage, type of lamp, driver, finish trim, ceiling type, mounting hardware of special requirements as specified hereinafter on as required by the particular installation(s) and code. Contractor shall verify these requirements and order fixtures as required to give proper installation per the contract documents and per code.

2.2 FIXTURE QUALITY AND DESCRIPTION

A. Manufacture luminaires to the specifications described herein and on the drawings.

2.3 FABRICATION

A. Provide luminaires, completely factory-assembled and wired and equipped with necessary drivers, wiring, shielding, reflectors, channels, lenses, etc., and deliver to job ready for installation.

2.4 MATERIALS

A. Plastic Lenses and Diffusers:

1. Virgin methyl methacrylate unless otherwise noted. De-staticize after cleaning. Install and leave with no finger prints or dirt marks on the lens or diffuser. Use white gloves if necessary.

2. Minimum nominal thickness for flat acrylic lens: .156 inch unless otherwise specified in the Fixture Schedule on the drawings.

2.5 LED LIGHT FIXTURES

A. General:

1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.

2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS) – compliant.

3. LED drivers shall include the following features unless otherwise indicated:

   a. Minimum efficiency: 85% at full load.
   b. Minimum Operating Ambient Temperature: -20° C. (-4°F)
   c. Input Voltage: 120-277V (+/-10%) at 60 Hz.
   d. Integral short circuit, open circuit, and overload protection.
   e. Power Factor: ≥ 0.95
   f. Total Harmonic Distortion: $\leq 20\%$
   g. Comply with FCC 47 CFR Part 15

4. LED modules shall include the following features unless otherwise indicated:

   a. Comply with IES LM-79 and LM-80 requirements.

   b. Minimum CRI 80 and color temperature 3000° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.

   c. Minimum Rated Life: 50,000 hours per IES L70.

   d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

B. LED Downlights:

1. Housing, LED driver, and LED module shall be products of the same manufacturer.

C. LED Troffers:

1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.

2. Housing, LED driver, and LED module shall be products of the same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Architect's and/or interior designers reflected ceiling plans show actual location of luminaires. Report to the Architect/Engineer any conflict between these plans and the electrical documents. Perform the work in accordance with the Architects/Engineers instructions. At the time of bid, include the most stringent requirement.

B. Spaces for luminaire insertion will be provided by the trade that installs the ceiling. Furnish plaster and other frames for setting and installing under another section of these specifications.

C. Install luminaires in mechanical and unfinished areas after ductwork and piping installation. Locate fixtures 8 feet 6 inches above floor or at suitable locations within space on walls but not lower than 7'-0" AFF. Where mounted lower than 8'-6" luminaires shall be protected by an approved wire guard.

D. The Contractor is required to protect luminaires from damage during installation of same and up to time to acceptance by the Architect/Engineer and any broken luminaires, glassware, plastics, lamps, etc., must be replaced by the contractor with new parts, without any additional expense to the Owner.

E. Pendant mounted units shall comply with the following:

1. Where 8' and 4' luminaires are mounted in a continuous row, luminaires, eight feet in length, shall have stems placed within 2'-0" apart. Stems shall be spaced symmetrically with a minimum of two (2) stems per eight foot fixture and one (1) stem per four foot fixtures so as to provide a uniform appearance throughout.

2. Individual luminaires, four feet or three feet in length, shall have two stems placed approximately 3 inches from each end.

3. Individual luminaires, eight feet in length shall have two stems placed approximately 4'-0" apart.

4. Each stem shall have a brass or steel swivel of other self-aligning device. The entire luminaire mounting (hickey, aligner, swivel, stem, etc.) shall be approved and provided by the fixture manufacturer.

5. A malleable iron bushing shall be placed at luminaire end of stem through which wire passes.

6. A pendant support using an approved sliding clevis bracket which firmly grips an indentation in rigid sides of the wiring channel will be acceptable.

7. Connections between outlet boxes and luminaires shall be by means of approved flexible raceways.

F. Where luminaires are mounted upon surface-mounted outlet boxes in surface mounted conduit runs, this Contractor shall furnish and install a luminaire canopy sufficiently deep to permit exposed conduits to pass through. Canopy shall have proper openings cut by luminaire manufacturer through which conduits may pass. Submit sample of canopy for approval before installation.

G. Where required by the local Building Department, provide approved wire guards over luminaires.

H. Prior to final payment this contractor shall clean all luminaires and replace all expended lamps. He shall also touch up all scratch marks, etc. in an approved manner.

I. Except as otherwise noted as a minimum procedure, support surface or pendant mounted luminaires:

1. Where weight is less than five pounds, from its outlet box by means of an interposed metal strap.

2. Where weight is from five to fifty pounds, from its outlet box by means of a hickey or other direct threaded connection.

3. Whose weight exceeds fifty pounds, directly from structural slab, deck or framing member.

J. Except as otherwise noted as a minimum procedure, support recessed luminaires:

1. Where weight is eighty pounds or less ceiling suspension members, as described above.

2. Where weight is more than eighty pounds directly from structural slabs, decks or framing members.

3. Where luminaires and ceilings are such as to require luminaire support from ceiling opening frames, include in the electric work the members necessary to tie back the ceiling opening frames to ceiling suspension members or slabs so as to provide actual support for the luminaires as noted above.

K. In conjunction with luminaires weighing less than fifty pounds the above restriction against supporting from suspended ceiling splines, runners or bars in the plane of the ceiling will be waived for ceilings which have been specifically approved for the weight and arrangement of luminaires being applied. Any support members, or other appurtenances, however, required to tie in or adapt the luminaires and their ceiling opening frames (if any) to the ceiling in the approved manner shall be included as part of the electric work.

L. In stairwells provide at minimum a luminaire of the type specified at each landing and at each intermediate landing.

M. Install exit lights as indicated on the drawings but not higher than 10'-0" AFF. All exit lights shall be installed with the downlight component fully operational.

N. Track luminaires, adjustable luminaires, floodlights, and accent lights shall be aimed as directed by the Architect/Engineer. Outdoor lighting shall be aimed in periods of darkness.

O. Recessed luminaires to be installed in metal pan or acoustic modular ceilings shall be modified as required to fit into openings in ceiling construction. This contractor shall coordinate and verify this work with the General Construction Contractor. Shop drawings showing details shall be submitted for approval.

P. Where indicated provide diodes for incandescent lighting circuits. Diodes shall be rated 300 watts and reduce input energy by 50% and light output by 30%.

Q. Plumb all outdoor lighting standards to true vertical. For bolted poles, provide galvanized anchor bolts and nuts. Plumb using a nut above and below the base plate on the anchor bolts. Pack grout between base plate and concrete footing and provide drain hole below base plate to prevent accumulation of moisture inside pole base. Provide two piece or individual covers for nuts exposed above the baseplate of the same color as the pole. Ground all metal lighting standards.

3.2 COORDINATION WITH MOUNTING CONDITIONS

A. This contractor is responsible for coordinating the mounting accessories and luminaire trims with the ceiling conditions for which each luminaire will be installed. No extra compensation will be permitted for failure to coordinate.

B. All luminaires in hung ceilings are to be installed with earthquake clips.

3.3 COORDINATION WITH AMBIENT CONDITIONS

A. This contractor is responsible for coordinating the characteristics and the U.L. labeling of the luminaires and their components with the ambient conditions which will exist when the luminaires are installed. No extra compensation will be permitted for failure to coordinate the luminaires with their ambient conditions. These areas of coordination include but are not limited to the following:

1. Wet location labels
2. Damp location labels
3. Low temperature
4. Dimming
5. Very low heat rise
6. Explosion proof
7. Fire rated ceilings
8. Low density ceilings
9. Insulated ceilings
10. EMI sensitive areas requiring shielded fixtures.

3.4 FINAL ADJUSTMENTS

A. Adjust lamp position, reflector/refractor position and aim fixtures as required.

END OF SECTION 26 51 00

SECTION 27 11 00 - COMMUNICATION EQUIPMENT ROOMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 GENERAL

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

B. This section includes the minimum requirements for equipment and cable installations in communication equipment rooms

C. This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

1.3 SCOPE

A. Provide the following:

1. Equipment racks and cabinets
2. Ladder Rack
3. Power strips
4. Horizontal and vertical cable managers
5. Grounding Bar and connections to all raceway and racks.

1.4 QUALITY ASSURANCE

A. All equipment rooms shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owners representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to approval.

B. Material and work specified herein shall comply with the applicable requirements of:

1. TIA – 569-B Commercial Building Standard for Telecommunications Pathways and Spaces

2. ANSI/TIA – 568-C Commercial Building Telecommunications Cabling Standard

3. ANSI/NECA/BICSI 568 – Standard for Installing Commercial Building Telecommunications Cabling

4. TIA – 606-A Administration Standard for Commercial Telecommunications Infrastructure

5. ANSI-J-STD – 607-A Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

6. ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers

7. NFPA 70 – National Electric Code

8. TIA – 569 Commercial Building Standard for Telecommunications Pathways and Spaces.

9. EIA-310-E, Cabinets, Racks, Panels, and Associated Equipment (most recent version).BICSI – Telecommunications Distribution Methods Manual.

1.5 SUBMITTALS

A. Provide product data for the following:

1. Equipment Racks
2. Cable management
3. Ladder Rack

PART 2 - PRODUCTS

2.1 CABLE MANAGEMENT

A. Provide horizontal and vertical and horizontal cable managers

B. Panels shall have front and back channels with covers.

C. Cable management panels shall be plastic and have integral wire retaining fingers, radius fingers for maintaining proper bend radius for Category 6 and optical fiber cables.

D. Management panels shall mount to any standard 19” rack and include all required mounting brackets and screws.

E. Provide 1U horizontal cable managers meeting following:

1. Lightweight plastic construction.
2. Dual hinged cover for cable access without removing cover.
3. Rounded edges on fingers protect cables from snags and damage to cable.
4. Flexible fingers for easy installation and removal of cables.
5. Increased finger spacing provides larger area for high performance Category 6 cables.

6. Pass-through holes allow front to rear cabling.
7. Include Covers, #12-24 and M6 mounting screws.

F. Provide Vertical cable managers front and back sides of rack. Racks butted together will share a common vertical manager. Vertical managers shall include the following:

1. Finger openings to accommodate up to 24 Category 6 cables.

2. Snap-on cable retainers can be placed on to fingers to help retain cables in channel during installation and maintenance.

3. Dual hinged covers can be opened 110° to the left or right to provide complete access to the cables inside the vertical pathway. Vertical managers include hinged covers, cable retainers, mounting brackets and #12-24 screws.

G. Design Makes:

1. Horizontal Panduit WMP1E
2. Vertical Panduit WMPV45E

H. Acceptable Manufacturers:

1. Commscope

2.2 EQUIPMENT RACKS

A. Free Standing Relay Racks

B. Racks shall be manufactured from aluminum extrusion.

C. Each rack shall have two L-shaped top angles, two L-shaped base angles and two C- shaped equipment-mounting channels. The rack shall assemble with nut and bolt hardware. The base angles shall be pre-punched for attachment to the floor.

D. Equipment mounting channels shall be 3” (76 mm) deep and punched on the front and rear flange with the EIA-310-D Universal hole pattern, 1-3/4” (44.45 mm) rack-mount spaces (U), to provide 45U, 52U or 58U for equipment. Each mounting space (U) shall be marked and numbered on the mounting channel.

E. When assembled with top and bottom angles, equipment-mounting channels shall be spaced to allow attachment of 19” EIA rack-mount equipment. Equipment attachment points shall be threaded with 12-24 roll-formed threads. The rack shall include assembly and equipment-mounting hardware. Racks shall include 50 each combination pan head, pilot point mounting screws.

F. The assembled rack shall measure 7’ (2.1 m)/84” (2133 mm) high, 8’ (2.4 m)/96” (2438 mm) high or 9’ (2.7 m)/108” (2743 mm) high; 20.3” (515.9 mm) wide and 15” (381.0 mm) deep. The sides (webs) of the equipment-mounting channels shall be punched to allow attachment of vertical cable managers along the sides of the rack or for rack-to-rack baying.

G. Assembly hardware shall electrically bond the top angles, side channels and base angles together when assembled, and there shall be a masked ground attachment point with 1/4- 20 threaded studs spaced 5/8" apart on the inside of the side channel to attach a ground lug allowing easy attachment to the Telecommunications Ground.

H. The rack shall be rated for 1,000 lb (453.6 kg) of equipment.

I. The rack shall be UL and cUL Listed as a Communications Circuit Accessory, DUXR and DUXR7 category, file number 140851.

J. Finish shall be either clear grained aluminum or epoxy-polyester hybrid powder coat in the color as specified below.

K. Design Make shall be: Chatsworth Products, Inc. (CPI). Standard Rack

1. Part Number 55053-703, Standard Rack, 7'H (2.1 m) x 20.3"W (515.9 mm) x 15"D (381.0 mm), 45U x 19"EIA, Black, UL Listed.

2. Part Number 40605-005, Equipment Mounting Screws, #12-24, 50 pack, Black.

3. Part Number 40604-003, Rack Installation Kit, Concrete Slab, Zinc.

L. Acceptable Manufacturers

1. Panduit
2. Hubbell
3. Dracon

2.3 CABLE RUNWAY (LADDER RACK)

A. Cable runways shall have hollow side bars nominally 3/8" thick by 1½"H with rungs 6" on center.

B. All steel construction. All accessories shall be of steel construction or compatible material. Provide with gray power coated finish.

C. Ladder rack will be UL Classified for suitability as an equipment-grounding conductor.

D. Include all hardware for securing trays to each other, to the rack and to the wall

E. Provide all required fittings, including, but not limited to:

1. Wall angle support brackets
2. Horizontal and Vertical elbows
3. Horizontal and Vertical offsets
4. Junction and reduction fittings
5. Cable drop "waterfall" fittings
6. Grounding lugs.

7. Equipment rack brackets

F. Design Make – Legrand Cablofil

G. Acceptable Manufacturers:

1. Mono-systems
2. Atlas
3. B-Line
4. Chalfant

2.4 D-RINGS

A. Provide D-rings on communications backboards for vertical and horizontal cable management.

B. Provide "D" rings 2 ft. on center for all exposed vertical cable runs terminated or routed exposed on the plywood backboards.

C. Install D-rings at a maximum 2'-0" on center

D. Design make – Senior Industries #SI-4755

E. Acceptable Manufacturers:

1. Wiremold
2. Atlas
3. B-Line
4. Chalfant

PART 3 - EXECUTION

3.1 FLOOR MOUNTED RACKS

A. General

1. Assemble relay racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.

2. All racks must be attached to the floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through the raised floor tile and be secured in the structural floor below.

3. Racks shall be grounded to the TGB using appropriate hardware provided by the contractor. The ground will meet local code requirements and will be approved by the Authority Having Jurisdiction (AHJ).

4. Ladder rack shall be attached to the top of the rack to deliver cables to the rack. The rack shall not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer.

5. The equipment load will be evenly distributed and uniform on the rack. Place large and heavy equipment towards the bottom of therack

B. Provide horizontal and vertical cable management as shown on rack elevations.

C. Mount back rack a minimum of 36" from wall when orientated parallel to wall and tight to wall (after allowing for vertical cable managers) when perpendicular to wall.

D. Ground each rack to the equipment ground bar or building steel with a #6 green copper wire.

3.2 CABLE MANAGEMENT

A. Provide racked mounted 2RU (3.5") horizontal cable managers as shown on rack elevations.

B. Install vertical cable managers, at the ends of each rack and between the racks. Provide closed end cap on exposed vertical end panels and provide rear hinged door (both items are accessories).

C. Provide at least one 2RU horizontal cable manager for each 24 port or 48 UTP port panel and fiber patch panel installed, even if not specifically detailed on the drawings.

D. Horizontal cabling management panels shall be placed to manage the patch cords between the patch panel and the equipment. Provide a minimum of one rack mounting space (RMS) panel for up to 24 patch cords and a two RMS panels for up to 48 patch cords.

3.3 LADDER RACK

A. Provide ladder rack in equipment rooms for routing equipment and backbone cables between cross-connects, equipment, and backbone pathways. Install trays or ladder racks overhead along the equipment rows from wall to wall and, leading to the cross-connects. Coordinate tray locations with lighting, air-handling systems, and fire extinguishing systems so that fully loaded trays will not obstruct or impede their operation.

B. Provide ladder rack from each sleeve, conduit, cable tray penetrations into each communication Rooms (up/down) vertically to support backbone and horizontal cables on 12" centers.

C. Secure rack to walls and to the top of the equipment racks.

D. Ground and bond all sections of runways.

E. Provide waterfalls and radius bends for proper cable routing and support, even if not specifically detailed on the drawings.

F. Ladder rack system shall be installed straight, level and perpendicular to walls and ceiling slabs.

G. Ladder racks shall be supported at 5' intervals maximum.

H. Provide all hardware, accessories, fasteners, anchors, threaded rods and support channels required to provide a complete ladder rack system.

3.4 MISCELLANEOUS REQUIREMENTS

A. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within a bundle, where the label is obscured from view shall not beacceptable.

B. Install factory supplied labels for each patch panel, in the corresponding T568A configuration, in all UTP patch panels, BEFORE beginning to terminate cables. Cables terminated onto a patch panel without said port label strip shall not be acceptable.

C. Fire Stop all sleeves and conduit openings at time or removal of existing abandoned cables and again at time of cable installation, as called for.

3.5 CLEANING

A. In all terminating spaces that have had floor or wall penetrations, hammer drilling, or core boring activities - a through brooming, vacuuming, and wet mopping/sponging shall be preformed. Cleaning shall include floors, walls, ladder trays, tops of cabinets/racks, existing/new passive and active components, per manufacturer recommendations.

B. All non-metallic cable managers and snap covers shall be wiped clean, both inside and outside of front, including rear channels. All clear covers and doors shall be cleaned, both front and rear per manufacturer recommendations.

C. Inside of fiber optic enclosure and patch panels shall be blown clean of settled dust. Said cleaning shall be performed for all new construction projects or where gypsum sanding has been performed.

D. All scraps, boxes, spools, pull line and trash shall be removed and properly disposed of.

E. All residual cable lubricant shall be cleaned from floors and walls with an appropriate degreaser.

3.6 GROUNDING AND BONDING

A. Each communications equipment room shall be provided with a telecommunications ground bar (TGB). The TGB shall be connected to the ground bus of the electrical panelboard feeding the communications equipment room. Provide (1) #6 AWG stranded grounding conductor with green insulation from the bus bar to the electrical system equipment grounding conductor.

B. The Contractor shall bond all racks, cabinets, metallic backboards, shielded cable, cable sheaths, metallic strength members, splice cases, cable trays, ladder runways, metallic conduits, metallic raceways, etc. entering in the communications equipment room to the respective TGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.

C. All wires used for telecommunications grounding purposes shall be identified with a green insulation. All cables and busbars shall be identified and labeled in accordance with TIA 606A.

D. Installation and termination of the main bonding conductor to the grounding electrode shall be performed by a licensed electrical contractor.

END OF SECTION 27 11 00

SECTION 27 12 00 - COMMUNICATIONS RACEWAY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 WORK INCLUDED

Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents. This work is included in the data cable contract.

1.3 SCOPE

A. All work in this Section is included in the cabling contract.

B. Provide the following raceways

1. Surface raceways where indicated on plans
2. Conduit for sleeves into rooms and for exposed cable in mechanical and utility spaces with no ceilings.
3. Cable hangers above accessible ceilings
4. Inner duct for interior backbone fiber optic cable.
5. PVC (below grade) and GRS (above grade) conduit with inner duct for exterior fiber optic

1.4 QUALITY ASSURANCE

A. All pathways and associated equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and work specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70)

a. 348-Electrical metallic tubing
b. 350-Flexible metal conduit
c. 352-Surface Metal Raceways and Surface Nonmetallic raceways
d. 362-Metal wireways and nonmetallic wireways
e. 645-Information Technology Equipment
f. 770-Optical Fiber Cables and Raceways
g. 800-Communications Circuits

2. The following American National Standards Institute (ANSI) standards:

a. ANSI-C80.3, 1983 Specification for Electrical Metallic Tubing, Zinc-coated.

3. The following U.L. Standards:
a. UL 1, 1985 Flexible Metal Electrical Conduit
b. UL 5, 1985 Surface Metal Electrical Raceways and Fittings
c. UL 514B, 1982 Fittings for Conduit and Outlet Boxes
d. UL 797, 1983 Electrical Metallic Tubing
e. UL 870, 1985 Electrical Wireways, Auxiliary Gutters and Associated Fittings

1.5 SUBMITTALS

A. Provide product data for the following:

1. Cable Hangers
2. Innerduct
3. Surface raceway
4. Conduit
5. Backboxes

PART 2 - PRODUCTS

2.1 CABLE HANGERS

A. Provide prefabricated, zinc coated, carbon steel or aluminum open top hangers designed specifically for Category 5E, Category 6 and Optical Fiber cable installation.

B. Hangers shall have open top, rolled edges with a 2” or 4” diameter loop as quantities require. Main runs on drawings shall be 4”. Secondary runs not indicated on drawings may be reduced to 2” if cable quantities allow.

C. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.

D. Provide nylon/velcro type cable ties to hold cables in hangers, install ties at the completion of the cable installation.

E. Acceptable Manufacturers:

1. Caddy
2. Garvin
3. B-Line

2.2 SURFACE RACEWAY

A. Refer to 26000 series specifications for materials.

B. Raceway shall be 2 channel power/data type where indicated on plans.

2.3 CONDUIT

A. Refer to 26000 series specifications for materials.

B. Provide EMT conduit sleeves where low voltage and communications cables are run through walls and for cables in mechanical rooms and storage areas below 10 ft. AFF.

C. Provide EMT conduit from recessed back boxes to ceiling space.

D. Refer to drawings for sizes.

E. Provide bushings on each end of conduit run.

F. Provide galvanized rigid metal conduit for exterior above grade exterior.

G. Provide schedule 80 direct buried PVC conduit for underground exterior.

2.4 INTERIOR INNERDUCT

A. Plenum-Listed Textile Innerduct: Micro (33mm), 3 inch two cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces.

B. Acceptable Manufacturers:

1. Carlon
2. Endot Industries
3. MaxCell

PART 3 - EXECUTION

3.1 GENERAL

A. Support raceways from building construction. Do not support raceways from ductwork, piping, or equipment hangers.

B. Support outlet boxes independently from building construction. Do not support from raceways.

C. Install raceways parallel or perpendicular to building walls, floors and ceilings.

D. Provide conduit in mechanical spaces with no ceilings.

E. Provide open top cable hangers 4 foot on center above accessible ceilings. See plans for main cable hanger runs. These runs shall be configured as shown in details and be 4" wide hangers.

F. Cut raceways square, ream ends to remove burrs, and bush where necessary.

G. Coordinate all raceway runs with other trades.

H. Do not install raceways adjacent to hot surfaces or in wet areas.

I. Provide sleeves, and fire atop all penetrations through floors.

J. Support all raceways with malleable iron pipe clamps or other approved method. In exterior or wet locations, provide minimum ¼" air space between raceway and wall. Secure raceway within 3 ft. of each outlet box, junction box, cabinet or fitting.

K. All open raceways shall be installed a minimum of 12 inch away from any light fixture or other source of EMI (electro-magnetic interface).

L. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.

M. Do not locate backbone cable pathways in elevator shafts.

N. Provide removable fire stopping in around sleeves and inside sleeves after cables are installed. Refer to architectural plans for wall and barrier ratings.

3.2 INSTALLATION

A. Conduit fill (Use for conduits or conduit sleeves)

Cable Outside Diameter

Inside Diameter (mm)	Trade Size	3.3 (0.13)	4.6 (0.18)	5.6 (0.22)	6.1 (0.24)	7.4 (0.29)	7.9 (0.31)	9.4 (0.37)	13.5 (0.53)
16	½	1	1	0	0	0	0	0	0
21	¾	6	5	4	3	2	2	1	0
27	1	8	8	7	6	3	3	2	1
35	1-1/4	16	14	12	10	6	4	3	1

41	1-1/2	20	18	16	15	7	6	4	2
50	2	30	26	22	20	14	12	7	4
63	2-1/2	45	40	36	30	17	14	12	6
78	3	70	60	50	40	20	20	17	7
91	3-1/2	-	-	-	-	-	-	22	12
100	4	-	-	-	-	-	-	30	14

B. Conduit bends:

If the Conduit has an internal Diameter of at least:	**The Bend Radius must be:**
51 mm (2 in.) or less diameter	6 times the internal conduit.
More than 51 mm (2 in.) diameter	10 times the internal conduit.

If a Conduit run requires:	**Then:**
More than two 90 degree bends	Provide a pull box between sections with two bends or less.
A reverse bend (between 100 degrees 180 degrees)	Insert a pull point or pull box at each bend having an angle from 100 degrees to 180 degrees.
A third 90 degree bend (between pull Points or pull boxes)	De-rate the design capacity by 15% for this additional bend.

C. Sleeves:

1. Provide conduit sleeves through all walls.
2. Slots and sleeves to conform to appropriate codes and standards.
3. Slots with a minimum of 25 mm (1 in.) high curb.
4. Sleeves to extend a minimum of 25 mm (1 in.) above the floor level.
5. After cable installation is complete and tested, provide a putty or pillow type fire stop in all sleeves.

D. Surface Raceways:

1. Support with expansion anchors, concrete inserts, masonry inserts or toggle bolts as field conditions require. Provide supports at five foot centers.

2. Provide all fittings, connectors, elbows, extension rings, tees, offset connectors, boxes, etc. as required as installation that conceals all cables and maintains all cable bending radius.

3. Surface raceway shall be filled at 60% maximum.

E. Ceiling space as a pathway:

1. Cables shall be supported 4’ on center using open top cable supports adequate for the weight of the cables. Ceiling tiles shall not be used to hang cable or cable supports without the approval of the Owner.

2. Cables shall be installed at least 3 in. above the ceiling tiles.

3. Do not fasten cables to fire rated suspended ceilings.

3.3 CABLE HANGERS

A. Provide cable hangers 4’ on center wherever cable tray or conduit is not present.

B. Load hangers as recommended by the manufacturer.

C. Do not support cable from ceiling system tie wires or grid in fire rated systems.

D. Suspended cables must be installed with at least 76 mm (3 in.) of clear vertical space above the ceiling tiles and support channels (T-bars).

E. Installation and configuration shall conform to the requirements of ANSI/TIA-568-C.0, ANSI/TIA-568-C.1 & ANSI/TIA-569-B, NFPA 70 (National Electric Code), applicable local codes, and to the manufacturer’s installation instructions.

F. Install cables using techniques, practices, and methods that are consistent with Category 6 or higher requirements and that support Category 6 or higher performance of completed and linked signal paths, end to end.

G. Install cables without damaging conductors, shield, or jacket.

H. Do not bend cables, in handling or in installing, to smaller radii then minimums recommended by manufacturer.

I. Pull cables without exceeding cable manufacturer’s recommended pulling tensions. Use pulling leans that will not damage media.

J. Do not exceed load ratings specified by manufacturer.

K. To avoid electromagnetic interference (EMI), pathways shall provide minimum clearances of four feet from motors or transformers, one foot from conduit and cables used for electrical power distribution, and five inches from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables or conduits.

3.4 INNERDUCT

A. Innerduct Installation:

1. Place innerduct above ceilings in interior spaces.

2. Provide unspliced lengths of innerduct between maintenance holes, pull boxes, and/or termination points.

3. Make a 2" incision, approximately 18" from the end of textile innerduct. Pull out and cut off approximately 2 feet of pull-tape. Thus allowing the pull tape ends to retract back into the cells.

4. Using approximately 6' of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of the innerduct. Apply black vinyl tape over all mknots and the end of innerduct. Using a bow line knot, tie a swivel to the end of 3' pull tape, for multi-pack installations one swivel is sufficient, but stagger each textile innerduct.

5. Using a bow line knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install the innerduct, ensuring that no twist is introduced to the innerduct.

6. Provide suitable innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.

7. Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support. Design & install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.

8. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires.

9. At locations where textile innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.

10. At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.

11. Cable Tray and Runway Installation: Cut incisions every 24 inches into the edge of the textile innerduct and cable wrap to one side of vertical ladder rack or horizontal ladder-type cable tray at each incision.

3.5 PATCHING AND PAINTING

A. Patch all openings around sleeves with fire proofing material.

END OF SECTION 27 12 00

SECTION 27 13 00 - BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract including all general conditions, supplementary conditions, Division 1 specification sections as well as information to Bidders requirements that are included in the project documents, apply to the work of this contract.

1.2 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the contract documents.

1.3 SCOPE

A. Backbone cabling includes copper and optical fiber cabling from the service entrance to the main communication rooms and cable between the main communication room and secondary communication rooms.

B. Work specified in this section is included in the cabling contract.

C. This section includes minimum requirements for the following:

1. Optical Fiber and Connectors
2. Optical Fiber Enclosures

1.4 QUALITY ASSURANCE

A. All cable shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contracts documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturer listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials and work specified herein shall comply with the applicable requirements of:

1. ANSI/TIA/EIA-568B.X (2000 or newer edition)
2. ANSI/TIA/EIA-569A (1998 or newer edition)
3. NFPA 70-2002
4. BICSI Telecommunications Distribution Methods Manual, current edition
5. FCC 47 CFR 68
6. NEMA-250

7. NEC-Articles 725, 760, 770 and 800
8. IEEE C2 National Electrical Safety Code
9. ISO/IEC 11801
10. ANSI-J-STD-607-A
11. ANSI/TIA/EIA 606-A (2002 or current edition)
12. ANSK-NECA-BICSI 568 (2001 or current edition)

C. The optical fiber cable plant shall be used to support Gigabit and 10-Gigabit Ethernet networks.

D. If this document and any of the document6s listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.5 SUBMITTALS

A. Manufacturers catalog sheets, specifications and installation instructions for all cable, connecting hardware and patch cables.

B. Termination details for all cable types.

C. Cable Test Reports (at substantial completion).

D. Cable tension reports for optical fiber pulls backbone pulls over 200'.

PART 2 - PRODUCTS

2.1 FIBER OPTIC CABLE INDOOR/OUTDOOR

A. Cable shall be loose tube gel-free plenum type. Cable shall have water-swellable yarn eliminating the need for gel-fitting.

B. Flame-retardant outer jacket, UV resistant allowing direct exposure to sunlight.

C. Meeting the requirements of the National Electrical Code® (NEC®) Article 770, the cables are also OFNP and FT-6 listed.

D. All fibers in the cable must be usable fibers and meet required specifications.

E. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

F. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

G. All optical fibers shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi.

H. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

I. The coated fiber shall have a layer of Teflon* placed between the dual layer acrylate coating of the optical fiber and the thermoplastic buffer. The diameter of the thermoplastic buffer coating shall be 900 ± 50*m.

J. The fiber coating and buffer shall be removable with commercially available stripping tools in a single pass.

K. The multimode fiber utilized shall be 50um. laser optimized extended 10G distance (OM4)

1. Core diameter: 50 ± 3.0 um.
2. Cladding diameter: 125.0 ± 2.0 um.
3. Core-to-Cladding Offset: ≤ 3.0 um.
4. Cladding non-circularity: ≤ 2.0%
5. Core non-circularity: ≤ 6.0%
6. Coating Diameter: 245 ± 10 um.
7. Graded index
8. Numerical Aperture: 0.275 ± 0.015
9. Attenuation Uniformity: There shall be no point discontinuities greater than 0.2 db at either 850 nm or 1300 nm.

L. The non-dispersion shifted single-mode fiber utilized in the cable specified herein shall conform to the following specifications:

1. Typical Core Diameter: 8.3 um.

2. Cladding Diameter: 125.0 ± 1.0 um.

3. Core-to-Cladding Offset: ≤ 0.6 um.

4. Core non-circularity: ≤ 1.0%

5. Coating Diameter: 245 ± 10 um.

6. Attenuation Uniformity: No point discontinuity greater than 0.1 db at either 1310 nm or 1550 nm.

7. Attenuation at the Water Peak: The attenuation at 1383 ± 3 nm shall not exceed 2.1 db/km.

8. Cutoff Wavelength: The cabled fiber cutoff wavelength shall be < 1260 nm.

9. Mode Field Diameter: 9.30 ± 0.50 um at 1310 um, 10.50 ± 1.00 um at 1550 nm.

10. Zero Dispersion Wavelength (λo) – 1301.5 nm ≤ λo ≤ 1321.5 nm.

11. Zero Dispersion Slope (So) - ≤ 0.092 ps (nm^2•km).

12. Fiber Curl: > 4.0 m radius of curvature.

M. The attenuation specification shall be a maximum attenuation for each fiber at 23 ± 5°C.

N. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.1 dB at 1310 nm (single-mode) or 0.2 dB at 850 nm/1300 nm (multimode) in any one kilometer length of fiber.

O. The cable shall withstand a minimum compressive load of 890 N/cm (500 lbf/in) applied uniformly over the length of the compression plate. The cable shall have an aluminum or steel interlock armor that increases the crush resistance at least ten times that of standard fiber cable, typically 89 N/cm (50 lbf/in). the cable shall be tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables." While under compressive load, the fibers shall not experience an attenuation change greater than 0.4 dB at 1550 nm (single-mode) or greater than 0.6 dB at 1300 nm (multimode). After the compressive load is removed, the fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single-mode) or greater than 0.4 dB at 1300 nm (multimode).

P. The cable shall withstand a minimum of 20 impact cycles. The cable shall be tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies." The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single mode) or greater than 0.4 dB at 1300 nm (multimode).

Q. The cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute. The cable shall be tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test." The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single mode) or greater than 0.4 dB at 1300 nm (multimode).

R. Design Make: Corning Cable Systems FREEDOM®

S. Acceptable Manufacturers:

1. Belden
2. OCC
3. AMP

2.2 OPTICAL FIBER CABLE CONNECTORS

A. High-precision connectors with insert loss – 0.1 dB typical/0.5 dB maximum per connector pair for multimode, 0.2 dB typical/0.5 dB maximum per connector pair for single-mode.

B. Laser Optimized Multimode Fiber Connectivity OM4

1. The optical fiber field-installable connector shall be LC, for installation onto multimode a laser optimized 50/125-micron fiber.

2. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers.

3. The optical fiber field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.

4. The optical fiber field-installable connector shall have a maximum loss of 0.5 dB.

5. The optical fiber adaptor module that occupies the faceplate shall be equipped with zirconia ceramic sleeve.

6. Laser optimized multimode fiber connector color shall be aqua.

C. Single Mode Fiber Connectivity (OS2)

1. The optical fiber field-installable connector shall be SC, for installation onto single mode 8.3/125-micron fiber.

2. The optical fiber field-installable connector shall meet or exceed the performance criteria found in 8.3/125-micron fiber.

3. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.

4. The preferred method of terminating loose-tube single-mode fiber is pigtail splicing into a rack mounted optical fiber panel or wall mounted enclosure. Pigtails shall be factory terminated and 3 meters in length. A fiber enclosure with slack storage trays must be used when pigtail-splicing method is used.

5. The splice loss through each connector pair shall not exceed 0.50 dB.

6. The optical fiber adaptor module that occupies the faceplate shall be equipped with zirconia ceramic sleeve/

D. Design Make: Corning Cable Systems UniCam High Performance SC

E. Acceptable Manufacturers:

1. AMP
2. OCC
3. Leviton

2.3 FIBER ENCLOSURE

A. Shall be rack mounted.

B. Front and rear transparent polycarbonate doors and chassis covers.

C. Magnified label holders to clearly identify fiber connections.

D. Shall be constructed with 16 gauge steel.

E. Housings have sliding tray (01U and 02U) or open top at front (02U and 04U).

F. Meets ANSI/TIA/EIA-568A and 606.

G. 17” enclosure depth.

H. Fiber management rings that are adjustable and stackable for optimized fiber slack organization.

I. Mounting provisions for buffer tube fan-out kits.

J. Provide SC connector housing panels as required to accommodate all fiber called for.

K. Shall accommodate 24, 48, 72 or 96 fibers as called for on the drawing rack elevations and drawings.

L. Design Make: Corning CCH series.

PART 3 - EXECUTION

3.1 OPTICAL FIBER

A. Bending Radius:

1. Do not exceed the cable’s minimum based radius. Bending cable tighter than the minimum bend radius may result in increased optical fiber attenuation, optical fiber breakage, or the development of micro-fractures.

2. Nonconductive backbone optical fiber cables shall have a minimum bend radius of 10 times the cable’s outside diameter when under no load and 15 times the cables outside diameter when being pulled.

3. Conductive backbone optical fiber cables shall have a minimum bend radius of 10 times the cable’s outside diameter when under no load and 20 times the cables outside diameter when being pulled. Check manufacturer’s specifications on the cable bend radius requirements.

B. Furnish strain relief at top of vertical rise.

C. Innerduct shall be placed with entrance cable for fiber optic installations.

D. Innerduct shall be provided for all interior building optical fiber cables, in a minimum of 1” diameter. Place innerduct inside EMT conduits or provide plenum rated. Place a spare pull-line in during installation of the innerduct.

E. Optical Fiber splices are not allowed. Should fiber be broken during installation the entire run shall be replaced.

F. Interior cable installed in accessible ceilings shall be installed in open top cable hangers 4 foot on center or in cable tray. Install the cables as close to the ceiling deck as possible in a segregated pathway. Do not install with UTP or coax cables.

G. Provide tie wraps to close top of cable hangers after installation is complete.

H. Exterior cable shall be installed in innerducts run in conduit.

I. Maintain polarization for entire system as described in ANSI/EIA/TIA-568-A section 12.7.1.

END OF SECTION 27 13 00

SECTION 27 15 00 - HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, and services to perform the work required for a complete installation as required in the Contract Documents.

B. Work specified in this section is included in the cabling contract.

C. This section shall include the following:

1. Category 6 cable
2. Patch Panels
3. Communications Faceplates
4. Termination Jacks
5. Patch Cords

1.3 REFERENCES

A. The products and work herein specified shall comply with the current additions of the following publications and standards.

1. UL - Underwriter Laboratory

2. NEC – National Electric Code
   a. Article 725
   b. Article 770
   c. Article 800

3. NFPA – National Fire Protection Association

4. NECA - Standard of Installation

5. ANSI – American National Standards Institute

6. NEMA – National Electrical Manufactures Association
   a. Article 250

7. EIA – Electronic Industries Alliance

    a. ANSI/TIA/EIA-568-C.2.
    b. ANSI/EIA/TIA 569B
    c. ANSI/EIA/TIA 606A
    d. ANSI-J-STD-607-A
    e. ANSI/TIA/EIA-606-A

8. TIA – Telecommunications Industry Association

9. IEEE C2 National Electrical Safety Code

10. FCC - Federal Communications Commission

    a. CFR 68

11. BICSI – Building Industry Consulting Services International

    a. Distribution Methods Manual
    b. ANSK/NECA/BICSI 568

12. ISO/IEC 11801

B. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.4 QUALITY ASSURANCE

A. All work shall be provided in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents, shall be provided in accordance with industry standards and shall be subject to the control and approval of the Owners representative.

B. Equipment and materials shall be of the quality and manufactures indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to the approval of the Engineer.

C. Strictly adhere to all Category 6 (BICSI and TIA) and manufacturer recommended installation practices when installing high performance cabling.

D. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

E. The contractor shall furnish a list of three (3) installations of equivalent or larger systems that have been installed within the past two (2) years and have been operating satisfactorily for a minimum of one year. (Include names and phone numbers of references) with bid.

F. Cable and Jack shall be warranted for a period of 10 Years from the manufacturer.

1.5 SUBMITTALS

A. Provide manufactures cut-sheets, specifications, and installation instructions for the products herein specified.

1. Category 6 cable
2. Patch Panels
3. Communications Faceplates
4. Wall Phone Faceplates
5. Termination Jacks
6. Patch Cords

B. Termination details for all cable types.

PART 2 - PRODUCTS

2.1 DATA COMMUNICATIONS HORIZONTAL CABLING (CATEGORY 6 CLASS)

A. Category 6/Class E Unshielded Twisted-Pair (UTP) Cable.

B. All Cables shall be of round construction.

C. Each cable shall contain 4 color coded pairs.

D. Cable shall be listed for the environment where it will be installed (Plenum, Riser, LSZH, etc.).

E. Basis for Design Specifications: CommScope Uniprise Category 6 Media 6® Category 6 U/UTP Cable.

F. Approved Manufacturer: No substitutions: CommScope Uniprise, Catalog/Manufacturer Part Number:

1. 75N4 – Riser Cat 6
2. (See Appendix A for Approved Materials List)

G. Category 6 horizontal cabling shall meet or exceed the following specifications:

1. Construction Materials

a. Jacket Material PVC
b. Conductor Material Bare copper
c. Insulation Material Polyolefin
d. Separator Material Polyolefin
e. Dimensions
f. Cable Length 305m | 1000 ft

g. Cable Weight 24.62 lb/kft
h. Diameter Over Jacket 5.842 mm | 0.230 in
i. Jacket Thickness 0.508 mm | 0.020 in

2. Electrical Specifications

a. ANSI/TIA Category 6

b. Characteristic Impedance 100 ohm

c. Dc Resistance Unbalance, maximum 5%

d. Dc Resistance, maximum 6.66 ohms/100 m

e. Delay Skew, maximum 45 ns

f. Mutual Capacitance 5.4 nF/100 m @ 1kHz

g. Nominal Velocity of Propagation (NVP) 69%

h. Operating Frequency, maximum 400 MHz

i. Transmission Standards ANSI/TIA•568•C.2 | CENELEC EN 50288•6•1 | ISO/IEC 11801 Class E

j. Safety Voltage Rating 300 V

k. Dielectric Strength, minimum 1500 Vac | 2500 Vdc

l. Note: All electrical transmission tests include swept frequency measurements.

3. Environmental Specifications

a. Environmental Space Non•plenum/Plenum
b. Flame Test Method CMR/CMP
c. Installation Temperature 0 C to+60 C (+32 F to +140 F)
d. Operating Temperature •20 C to +60 C (•4 F to +140 F)
e. UL Temperature Rating 75 C | 167 F

4. General Specifications:

a. Cable Type U/UTP (unshielded).
b. Pairs, quantity 4.
c. Cable Component Type Horizontal.
d. Packaging Type box.
e. Conductor Gauge,singles 23 AWG
f. Conductor Type, singles Solid

H. Category 6 horizontal cabling shall meet or exceed the performance specifications listed in the following table.

Freq. MHz	IL			NEXT			ACR			PSNEXT			PSACR			ACRF			PSACRF			RL			TCL		ELTCTL	
	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	Typ	CS	Std	CS	Std
1	2.0	2.0	2.1	77.3	74.3	92.6	75.3	72.3	90.5	75.3	72.3	90.7	73.3	70.3	88.6	68.8	67.8	85.1	65.8	64.8	83.8	20.0	20.0	34.5	40.0	40.0	35.0	35.0
4	3.8	3.8	3.9	68.3	65.3	85.0	64.5	61.5	81.1	66.3	63.3	82.9	62.5	59.5	79.0	56.8	55.8	73.3	53.8	52.8	72.1	23.6	23.0	33.1	40.0	40.0	23.0	23.0
8	5.3	5.3	5.3	63.8	60.8	80.8	58.5	55.4	75.5	61.8	58.8	78.7	56.5	53.4	73.3	50.7	49.7	67.5	47.7	46.7	66.3	25.4	24.5	34.4	40.0	40.0	16.9	16.9
10	5.9	6.0	6.0	62.3	59.3	79.2	56.4	53.3	73.2	60.3	57.3	77.1	54.4	51.3	71.1	48.8	47.8	65.5	45.8	44.8	64.3	26.0	25.0	35.7	40.0	40.0	15.0	15.0
16	7.5	7.6	7.5	59.2	56.2	76.3	51.7	48.7	68.8	57.2	54.2	74.0	49.7	46.7	66.5	44.7	43.7	61.5	41.7	40.7	60.2	26.0	25.0	35.7	38.0	38.0	10.9	10.9
20	8.4	8.5	8.4	57.8	54.8	74.6	49.4	46.3	66.2	55.8	52.8	72.4	47.4	44.3	64.1	42.8	41.8	59.6	39.8	38.8	58.3	26.0	25.0	37.0	37.0	37.0	9.0	9.0
25	9.4	9.5	9.4	56.3	53.3	73.0	46.9	43.8	63.7	54.3	51.3	70.9	44.9	41.8	61.5	40.8	39.8	57.6	37.8	36.8	56.3	25.3	24.3	38.1	36.0	36.0	7.0	7.0
31.25	10.6	10.7	10.5	54.9	51.9	71.7	44.3	41.2	61.2	52.9	49.9	69.6	42.3	39.2	59.1	38.9	37.9	55.6	35.9	34.9	54.3	24.6	23.6	38.2	35.1	35.1		
62.5	15.3	15.4	14.9	50.4	47.4	66.2	35.1	32.0	51.3	48.4	45.4	64.1	33.1	30.0	49.2	32.9	31.9	49.3	29.9	28.9	48.1	22.5	21.5	36.8	32.0	32.0		
100	19.7	19.8	19.0	47.3	44.3	63.5	27.6	24.5	44.5	45.3	42.3	61.3	25.6	22.5	42.4	28.8	27.8	44.9	25.8	24.8	43.8	21.1	20.1	33.6	30.0	30.0		
155	25.0	25.2	23.9	44.4	41.4	61.3	19.5	16.3	37.4	42.4	39.4	58.8	17.5	14.3	35.0	25.0	24.0	40.8	22.0	21.0	39.7	19.8	18.8	32.0	28.1	28.1		
200	28.8	29.0	27.3	42.8	39.8	58.9	14.0	10.8	31.6	40.8	37.8	56.9	12.0	8.8	29.6	22.8	21.8	38.6	19.8	18.8	37.5	19.0	18.0	31.1	27.0	27.0		
250	32.6	32.8	30.7	41.3	38.3	56.8	8.7	5.5	26.1	39.3	36.3	54.8	6.7	3.5	24.1	20.8	19.8	36.6	17.8	16.8	35.5	18.3	17.3	30.6	26.0	26.0		
300	36.2		33.9	40.1		55.4	4.0		21.5	38.1		53.5	2.0		19.6	19.3		34.8	16.3		33.7	17.8		30.7				
350	39.5		36.8	39.1		54.3	-0.4		17.5	37.1		52.3	-2.4		15.5	17.9		33.4	14.9		32.1	17.3		31.1				
400	42.7		39.4	38.3		53.0	-4.4		13.5	36.3		51.1	-6.4		11.6	16.8		32.1	13.8		30.8	16.9		32.5				
500			44.7			50.7			6.0			48.7			4.0			28.9			27.6			33.8				
550			44.9			50.9			6.0			48.8			3.9			28.7			27.3			33.6				
650			51.5			47.0			-4.4			45.0			-6.4			24.4			22.9			26.2				

1. The table provides reference values only. All parameters comply with the governing equations over the entire frequency range.

2. All values and equations apply to worst-case channels utilizing four-pair cables with full cross-connects, consolidation points and work area outlets (4 connectors in a channel) for any channel lengths up to 100 meters.

I. Design Make: Belden Data Twist 4800 non bonded

J. Acceptable Manufacturers:

1. Commscope
2. Berktek
3. Amp

2.2 CATEGORY 6 CONNECTING HARDWARE

A. Category 6 compliant modular jacks.

B. Performance terminated on a 100M length of cable shall match requirements listed for Category 6 cable.

C. Physical Characteristics:

1. Jacks shall be 8 position un-keyed.

2. Each jack shall be an individually constructed unit and shall snap mount in an industry standard keystone opening (.760” x 580”).

3. Jack housings shall be high impact 94 V-0 rated thermoplastic.

4. Jacks shall have a temperature rating of -10 °C (14°F) to 60°C (140 °F) in conformance with ANSI/TIA/EIA-568-A.

5. Jacks shall utilize a 2 layer printed circuit board to control NEXT.

6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.

7. Housing shall be ultrasonically welded for tamper resistance.

8. Modular jack contacts shall accept a minimum of 2500 mating cycles without degradation of electrical or mechanical performance.

9. Contacts will maintain a minimum vertical deflection force of 100 grams over deflection window.

10. Modular jack contact wires shall be formed flat for increased surface contact with mated plugs.

11. Contacts shall be arranged on the PC board in 2 staggered arrays, one array has 6 contacts and the other array has 2 contacts.

12. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.

13. Contact Plating shall be a minimum of 50 micro inches of hard gold in the contact area over 50 micro-inch of nickel.

14. Jack termination shall follow the industry standard 110 IDC.

15. IDC contact termination towers shall be paired and angled at 29.5 degrees.

16. IDC contacts shall be laid out in staggered arrays of 4 sets of 2 contacts.

17. Jacks shall have a designation indicating Category 6 on the nose which can be plainly seen from the front of the faceplate. Bottom of jack shall have date code and an abbreviated catalog number.

18. Jacks shall utilize a paired punch down sequence. Cable pair twists shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.

19. 110 IDC shall utilize 100 micro-inch tin lead plated (60% tin/40%lead) over phosphor bronze over nickel.

20. Jacks shall terminate 22-26 AWG stranded or solid conductors.

21. Jacks shall terminate insulated conductors with outside diameters up to .050”

22. Jacks shall be compatible with single conductor 110 impact termination tools.

23. Jacks shall include translucent wire retention stuffer cap, that hold terminated wires in place and allow the conductors to be visually inspected in the IDC housing.

24. Stuffer cap shall have a positive locking latch to provide conductor strain relief.

25. Stuffer cap used for wire termination with channel lock style pliers.

26. Jacks shall be compatible with TIA/EIA 606 color code labeling

27. Jacks shall accept snap on icons for identification or designation of applications.

28. Jacks shall be available in 6 colors for identification or designation of applications at the workstation or telecommunication room.

29. Jacks shall have universal wiring designation.

30. Jacks shall be marked with the T-568A wiring scheme.

31. Jacks shall have an attached color coded wiring instruction label housed between the IDC termination towers.

32. Jacks shall be manufactured in the USA.

33. Jacks shall be designed for 100 Ohm UTP cable termination.

34. Jacks shall be UL LISTED 1863 and CSA certified.

35. Jacks shall be made by an ISO 9002 Certified Manufacturer.

D. Design Make: Belden Cat6+

E. Acceptable Manufacturers:

1. Panduit
2. Amp
3. Hubbell

2.3 UTP PANELS

A. Physical Characteristics:

1. Panels shall be made of 16ga cold rolled steel with a black powder coat finish in 48 port configurations.

2. Panels shall be manufactured with a rolled-edge at the top and bottom for stiffness.

3. Panels shall have 48 modular openings

4. Panels shall have Flame retardant UL 94 V-0 modular jacks with high performance copper alloy contacts and precious metal plating.

5. Panels shall be equipped with 110-style termination made of fire retardant UL 94V0 rated thermoplastic and tin lead solder plated IDC.

6. Panels shall have port identification numbers on both the front and rear of the panel. Front port identification on the 48 port panels shall be located between the rows of jacks.

7. Panels shall have rear cable support bar for strain relief. Cable support bar shall attach to the rear of the patch panel itself without the use of additional fasteners or screws.

8. Panels shall feature vertical panel ID label holders. Provide laser printed adhesive lables.

B. Design Make: Belden Cat6+

C. Acceptable Manufacturers:

1. Panduit
2. Amp
3. Hubbell

PART 3 - INSTALLATION

3.1 GENERAL

A. Firestop conduit openings after the cable installation is complete.

B. Separation from Electromagnetic Interference:

Condition	Minimum Separation
Distance Unshielded power lines or electrical equipment in proximity to open or Non-metal pathways.	610 mm (24 in)
Unshielded power lines or electrical in) equipment in proximity to a grounded metal conduit pathway.	305 mm (12
Power lines enclosed in a grounded in) metal conduit (or equivalent shielding) in proximity to a grounded metal pathway.	152 mm (6
Electrical motors and transformers.	1194 mm (47 in)

C. Installing cables above suspended ceilings

1. Pull or place cables into the zone pathway.

2. Leave sufficient slack in the ceiling to reach any telecommunications outlet/connector within the zone.

3. Where zone pathways are not provided, divide the floor area into direct-run telecommunications zones.

4. Run all the cables to the center point of their zones.

5. From the center point of each zone, distribute the cables to work areas within that zone.

6. At the center point of each telecommunications zone, support all cables with a cable tie or similar device. Tightly cinched cable ties may have a detrimental effect on transmission performance and should be avoided.

7. Coil in a figure eight any cable that is not in service back to the end of the zone pathway. When required, cable-tie these coiled cables.

8. Label the cables and pathways for easy recognition and establish a working database for ongoing identification and maintenance of horizontal cables and pathways.

9. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 inch intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

D. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-B maximum fill for the particular raceway type.

E. Riser rated cable shall be installed in metallic conduit when installed in a plenum space.

F. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.

3.2 UTP CABLE

A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.

B. All wiring concealed in new walls or soffits shall be installed in metal conduits.

C. Wiring in existing walls with hollow cavities may be installed loose.

D. All exposed wiring shall be installed in surface metal raceway.

E. All wiring above ceilings shall be installed in cable tray or open top cable hangers and brackets.

F. Cable hangers above accessible ceilings shall be installed 4' on center attached to building structure. If cables have more than 12” of sag, install more hangers.

G. Do not untwist cable pairs more than 0.5 in. when terminating.

H. The Contractor shall be responsible for replacing all cables that do not pass required bandwidth and throughput tests.

I. Maximum length shall be 90 meters. (295 ft)

J. Maximum patch cable shall be 5 meters (16 ft)

K. Provide 10 ft service loop in the communications equipment room. Provide 3 foot service loop in ceiling above outlet. Slack should not be stored in bundled loops. Cable loops have had a degrading effect on cabling performance. Cable slack should be stored in an extended loop or in a figure-eight configuration to alleviate stress.

L. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.

M. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in closets. Leave sufficient cable for 90o sweeps at all vertical drops.

N. Do not tie-rap cable to a perpendicular support. Tie-raps shall be used to secure cables to other like cables or to an approved tie mount. Do not over tighten cable ties.

O. Install category 6 cable in a separate open cable hanger segment. Do not install with coaxial, optical fiber cable or any other cable type. If cables have more than 12" of sag, install more hangers.

P. Do not install UTP cable with more than 110N (25 lbs) pull force, as specified in EIA/TIA and BICSII TDDM practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on: long pulls inside conduit, pulls of multiple cables into a single small bore conduit, on conduit runs greater than 100 lineal feet with bends of opposing directions, and in conduit runs that exceed 180 degrees of accumulated bends. Use of tensile rated cords (i.e. fishing line) should be used for difficult or questionable pulls - to judge to go/no-go condition of the conduit and pulling setup.

Q. Care must be taken so that the cable does not bend at any location to a radius less than ten times the diameter of the cable. A cable feeder guide of suitable dimensions should be used between the cable reel and the face of the duct to protect the cable and guide it into the duct as it is payed off the reel.

R. As the cable is payed off the reel, it should be carefully watched and inspected for sheath defects. If defects are noticed, the pulling operation should be stopped immediately and the Engineer promptly notified of the defect. Kinks and/or other irregularities in the cable sheath should be removed or corrected as directed by the engineer.

S. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co- installed with all cable installed in any conduit.

T. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

U. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

V. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.

W. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.

X. Leave a minimum of 12" of slack for twisted pair cables at the outlet. Cables shall be coiled in the in-wall box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. In hollow-wall installations where box-eliminators are used, excess wire can be stored in the wall. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

Y. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

Z. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.3 UTP MODULAR JACKS

A. All cables shall be terminated with modular jacks that snap into a faceplate mounted on a wall outlet box, surface raceways or power pole.

B. Outlet boxes shall be secured to building with mechanical fasteners. Adhesive fasteners are not allowed.

C. Jacks shall be installed to provide minimal signal impairment by preserving wire pair twists as close as possible to the point of mechanical termination. The amount of untwisted in a pair as a result of termination to the jack shall be no greater than 0.5 inches (13mm).

D. Jacks shall be installed according to manufacturer's instructions and properly mounted in plates, frames, housings or other appropriate mounting device.

E. Jacks shall be installed such that cables terminated to the jacks maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts. Cables shall be terminated on jacks such that there is no tension on the conductors in the termination contacts.

F. All extra openings to be filled with blank inserts.

G. Terminate cable per EIA/TIA T-568A standard pin assignments.

H. Remove only as much cable jacket as is required for termination and trimming. Follow the manufacturer's instructions for mounting, termination, and cable management. Minimize the amount of untwisting in a pair as a result of termination to connecting hardware. For untwisting cabling, maintain pair twists as close as possible to the termination point. The amount of untwisting must not exceed 12.7 mm (0.5 in) for category 5e and higher cables.

3.4 TESTING

A. Refer to Section 271600

3.5 COMPLETION AND ACCEPTANCE

A. In all spaces that have had floor or wall penetrations, hammer drilling, or core boring activities - a through brooming, vacuuming, and wet mopping/sponging shall be preformed. Cleaning shall include floors, walls, ladder trays, tops of cabinets/racks, existing/new passive and active components, per manufacturer recommendations.

B. Submit copies of the following:

1. Cable Test Reports (at substantial completion).
2. Cable tension reports for optical fiber pulls backbone pulls over 200'.

3.6 PATCH PANELS

A. Panels shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the patch panel shall be no greater than 0.5 inches (13 mm)

B. Panels shall be installed according to manufacturer's instructions and properly mounted to a rack, cabinet, bracket or other appropriate mounting device.

C. Panels shall be installed such that cables terminated to the panel can maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts.

D. Cables shall be terminated on the panels such that there is no tension on the conductors in the termination contacts. Panels shall be properly labeled on front and back with the cable number and port connections for each port, as per cable schedule drawings.

E. All cables shall be neatly "dressed out" in equipment rooms. Cables to be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within a bundle, where the label is obscured from view shall not be acceptable.

G. Install factory supplied patch panel labels, in the corresponding T568A configuration, in all UTP patch panels, BEFORE beginning to terminate cables. Cables terminated onto a patch panel without said port label strip shall not be acceptable.

H. The cable jacket shall be maintained as close as possible to the termination point.

3.7 CEILING TILES

A. Replace all ceiling tiles that are damaged due to cable installation.

3.8 SEALING AND FIRESTOPPING

A. Installation of Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be as follows:

B. Provide fire-stop system seals at all locations where sleeves pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for dry wall construction.

C. Provide putty type fire stop inside all sleeves after the cable installation is complete.

D. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

E. The methods used shall incorporate qualities that permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.

END OF SECTION 27 15 00

SECTION 27 16 00 - TESTING AND IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, and services to perform the work required for a complete installation as required in the Contract Documents.

B. Work specified in this section is included in the cabling contract.

C. This section includes the minimum requirements for the testing, certification administration and identification of backbone and horizontal cabling, including;

1. Tester Calibrations / Factory Requirements
2. UTP testing and testers
3. Labels and labeling
4. Reports
5. Documentation
6. Record Copy and As-Builts
7. Test Acceptance
8. Warranty

1.3 REFERENCES

A. The products and work herein specified shall comply with the current additions of the following publications and standards.

1. UL - Underwriter Laboratory

2. NEC – National Electric Code
   a. Article 725
   b. Article 770
   c. Article 800

3. NFPA – National Fire Protection Association

4. NECA - Standard of Installation

5. ANSI – American National Standards Institute

6. NEMA – National Electrical Manufactures Association

   a. Article 250

7. EIA – Electronic Industries Alliance

   a. ANSI/EIA/TIA 568B.X
   b. ANSI/EIA/TIA 569A
   c. ANSI/EIA/TIA 606A
   d. TIA/EIA-J-STD-037

8. TIA – Telecommunications Industry Association

9. IEEE C2 National Electrical Safety Code

10. FCC - Federal Communications Commission

    a. CFR 68

11. BICSI – Building Industry Consulting Services International

    a. Distribution Methods Manual
    b. ANSK/NECA/BICSI 568

12. ISO/IEC 11801

B. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.4 QUALITY ASSURANCE

A. All work shall be provided in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents, shall be provided in accordance with industry standards and shall be subject to the control and approval of the Owners representative.

B. Equipment and materials shall be of the quality and manufactures indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to the approval of the Engineer.

C. Strictly adhere to all Category 6 (BICSI and TIA) and manufacturer recommended installation practices when installing high performance cabling.

D. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

E. The contractor shall furnish a list of three (3) installations of equivalent or larger systems that have been installed within the past two (2) years and have been operating satisfactorily for a minimum of one year. (Include names and phone numbers of references) with bid.

1.5 SUBMITTALS

A. Provide manufactures cut sheets, specifications, and installation instructions for the products herein specified.

1. Cable testers
2. Test heads
3. Adapter cords
4. Latest version of software applicable for each tester planned for use.

B. Provide written factory calibration recommendation letter and factory recommended field calibration intervals with bid.

C. Provide signed manufacturer factory calibration certification for each copper and fiber tester owned at time of bid response as a submittal. Certification shall have serial number, date and version of software of each tester.

D. For each tester planned for use on this project, provide a letter from the tester manufacturer indicating the correct interface adapters and test cords, and set-up procedures required to test perform the Category 6 permanent link and the Category 6, channel tests with the products identified for use on this project and the warranty requirements called for.

E. Sample documentation from previous job for administration, test results and as-built drawings.

F. At time of testing, provide a factory calibration certificate for each tester used and include these in each test report binder at the completion of the project.

G. Test reports (submit prior to substantial completion punch list is performed)

H. Two copies in binder format and 4 copies on compact disks containing all summary reports, full plot data test results, tester software tools required to view and inspect and print any selection of the test reports, spreadsheets, end to end reports and as built drawings called for at the completion of job.. The database for the completed job shall be stored and delivered on CD including the software tools required to view, inspect, and print any selection of test reports.

I. Technician certificates for successful completion of training for each of the field testers proposed to be used in this project.

J. One copy of a binder and two copies on compact disks containing all digital photographs called for at the completion of the job.

PART 2 - PRODUCTS

2.1 UTP TEST EQUIPMENT

A. Field test instruments shall meet the requirements of ANSI/TIA/EIA-568-C.2.I.

B. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years' experience in producing field test equipment.

C. Manufacturers must be ISO 9001 certified.

D. All test tools of a given type shall be from the same manufacturer, and have compatible electronic results output.

E. Test adapter cables/test heads must be approved by the manufacturer of the test equipment, for the specific cable and connectivity product used on this project. Adapters from other sources are not acceptable. Obtain written confirmation that the test heads and adapter planned fro use are proper and also obtain a written confirmation from the wire and connectivity manufactures that they also agree with the test heads and adapter selection chosen by the tester manufacturer.

F. Baseline accuracy of the test equipment must exceed TIA Level III, as indicated by independent laboratory testing.

G. A level III test unit is required to verify category 6 performance for both Category 6 permanent link and channel performance.

H. Test equipment must be capable of certifying Category 5, 5e, and 6 links.

I. Test equipment must have a dynamic range of at least 100 dB to minimize measurement uncertainty.

J. Test equipment must be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

K. Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.

L. Test equipment must be capable of running individual NEXT, return loss, etc measurements in addition to auto-tests. Individual tests increase productivity when diagnosing faults.

M. Test equipment must include a library of cable types by major manufacturer.

N. Test equipment must store at least 1000 Category 6 or 6 auto-tests in internal memory.

O. Test equipment must be able to internally group auto-tests and cables in project folders for good records management.

P. Test equipment must include technology for support of advanced measurements.

Q. Test equipment must make swept frequency measurements in compliance with TIA standards.

R. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.

S. The basic tests required are:

1. Wire Map
2. Length
3. Attenuation
4. NEXT (Near end crosstalk)
5. Return Loss
6. ELFEXT Loss
7. Propagation Delay
8. Delay skew
9. PSNEXT (Power sum near-end crosstalk loss)
10. PSELFEXT (Power sum equal level far-end crosstalk loss)

T. Shall test cable for compliance with the following applicable standards:

1. TIA Category 6: Permanent Link and Channel
2. TIA Category 3 and 5 per TIA TSB-67: Basic Link or Channel
3. ISO/IEC 11801 and EN 50173 Class C and D: Link
4. ISO/IEC 11801 and EN 50173 Class C and D (new): Permanent Link or Channel
5. Aus/NZ Class C and D: Basic Link or Channel
6. STP cabling, (IBM Type 1, 150)
7. ANSI TP-PMD IEEE 802.3 10BASE5, 10BASE2: Ethernet with coaxial cabling
8. IEEE 802.3 10BASE-T, 100BASE-TX, 1000BASE-T: Ethernet with twisted pair cabling
   IEEE 802.5: Token Ring, 4 Mbps or 16 Mbps

U. Shall perform the following tests as a minimum:

1. NEXT, NEXT @ Remote
2. Wire Map
3. Characteristic Impedance
4. Length
5. DC Loop Resistance
6. Propagation Delay Return Loss (RL), RL @ Remote
7. Delay Skew
8. Attenuation
9. Attenuation-to-Crosstalk Ratio (ACR), ACR @ Remote
10. Power Sum ACR, PSACR @ Remote
11. ELFEXT, ELFEXT @ Remote
12. Power Sum ELFEXT, PSELFEXT @ Remote
13. Power Sum NEXT, PSNEXT @ Remote

V. Shall use injector for complete wire mapping and TDR for determining cable length.

W. Shall measure NEXT for all six pair combinations and Attenuation on all four pairs from 1.0 to 350 MHz.

X. Design Make: Fluke “DSP 4000 or 4300 series”

Y. Acceptable Manufacturers:

1. Agilent
2. WaveTek
3. Lantek
4. Wirescope

2.2 OPTICAL FIBER CABLE

A. Field test instruments for multimode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-14-A.

B. Field test instruments for multimode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-7.

C. Multimode optical fiber light source

1. Provide 850nm and 1300nm +/- 20 nm wavelength LED light sources.

2. Spectral width of sources shall be </= 50nm for 850nm wavelengths and </= 140nm for 1300nm wavelengths.

3. The output of the light source shall be 8 MW for 62.5um core optical fiber.

4. Output Stability +/- 0.40 dB from 0 to 50 degrees C.

5. Long Term output stability +/- 0.10dB at 25 degrees C.

6. Power shall be from rechargeable Ni-Cad batteries.

7. Connector types shall include: SMA, FC, ST and SC.

8. Design make: Siecor Light source.

9. Acceptable Manufacturers:

a. Fluke
b. Wavetek
c. Lantek

D. Single mode optical fiber light source

1. Provide 1300nm and 1500nm +/- 20 nm wavelength Laser light sources.
2. Output Stability +/- 0.40 dB from 0 to 50 degrees C.
3. Long Term output stability +/- 0.10dB at 25 degrees C.
4. Power shall be from rechargeable Ni-Cad batteries.
5. Connector types shall include: SMA, FC, ST and SC.
6. Design make: Siecor OS-200D.
7. Acceptable Manufacturers:

    a. Fluke
    b. Meson
    c. Amp

E. Optical Power Meter

1. Calibrates against the National Institute of Standards and Technology (NIST) standard.
2. Provide 850nm, 1300nm and 1500nm +/- 20 nm wavelength test capability.
3. Measurement range shall be from 10 to -60 dBm.
4. Accuracy shall be +/- 5% at 0 to -50dBm and +/- 10% 10 to 0dBm and -50 to-60 dBm.
5. Resolution shall be 0.1 Db.
6. Connector types shall include: SMA, FC, ST and SC.
7. Design make: Siecor OM-100F.
8. Acceptable Manufacturers:

    a. Fluke
    b. Meson
    c. Amp

F. Optical Time Domain Reflectometer (OTDR)

1. Dual selectable wavelength: 850/1300 nm for multimode.
2. Dual selectable wavelength: 1310/1550 nm for singlemode.
3. Selectable cable index of refraction.
4. Visual fault locator for continuity checks and dead zone fault protection.
5. Display and printer connection for hard-copy documentation.
6. Equipped with launch jumper cable of sufficient length to offset entry" deadzone".
7. Design make: Siecor
8. Acceptable Manufacturers:

    a. Fluke
    b. Meson
    c. Amp

2.3 LABELS

A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.

B. Shall be preprinted or laser printed type. Handwritten labels are not acceptable.

C. Where used for cable marking provide vinyl substrate with a white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow – so that the labels are easily distinguishable.

D. Where insert type labels are used provide clear plastic cover over label.

E. Provide plastic tape 6 inches wide continuously printed and bright colored 18" above all direct buried services.

F. Provide engraved plastic laminated labels, signs and instruction plates. Labels shall be made of engraving stock melamine plastic laminate. Use 1/16" minimum for signs up to 20 square inches or 8 inches in length. Use 1/8" thick for larger sizes. All labels shall be punched for mechanical fastening.

G. Acceptable Manufacturers:

1. W.H. Brady
2. Panduit
3. Ideal

PART 3 - EXECUTION

3.1 GENERAL

A. Upon completion of the installation, the telecommunications contractor should provide three (3) full documentation sets to the Engineer for approval.

B. Documentation should be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine-generated (final) copies of all drawings should be submitted within 30 working days of the completion of each testing phase. At the request of the Engineer, the telecommunications contractor should provide copies of the original test results.

C. The Engineer may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests should be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test should be at no additional cost to the Owner.

D. Test documentation should be provided on disk within three (3) weeks after the completion of the project. The disk should be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). The results should include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last

calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document should detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment

3.2 COPPER CABLE TEST

A. A level III test unit is required to verify category 6 performance, shall be updated with the latest version of tester software at time of testing and shall be factory tested/calibrated within one of time of testing. At time of testing, provide a factory calibration certificate for tester used and include these in each test report binder at the completion of the project.

B. Visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport. Visibly damaged goods are to be returned to the supplier and replaced at no additional cost to the Owner.

C. If post-manufacture performance data has been supplied by the manufacturer of cables or connecting hardware, copies of such data are to be kept for inclusion in the Documentation for final Record Copy deliverables and made available to the Owner upon request.

D. Test 100% of installed backbone copper cabling for:

1. Wire Map
2. Length

3.3 100 OHM UTP CABLE TESTING

A. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B.

B. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

C. The testing parameters called for in this section shall apply for up to 90 meters of horizontal cable, a work area equipment cord, an RJ45 outlet and 2 cross connect connections in the closet.

D. Wire Map

1. The wire map test shall verify pair to pin termination at each end and check for connectivity errors. The wire map shall indicate the following for each of the eight conductors:

    a. Continuity to the remote end
    b. Shorts between any two or more conductors
    c. Crossed pairs or Reversed Pairs

d. Split Pairs
e. Any other mis-wiring

E. Performance:

1. Cables shall be tested for conformance called for in Section 27 15 00.

F. Data reporting and accuracy:

1. General: a Pass or Fail result for each parameter shall be determined by the allowable limits for each parameter. If the test result of a parameter is closer to the test limit than the accuracy of the tester it shall be marked with an asterisk. Data at all measured points shall be uploaded to a P.C. and printed on a laser printer.

2. Wire Map: Wire map tests shall be marked “Pass” if wiring is determined correct.

3. Length: Test results shall be provided in meters and marked “Pass or Fail” based on the length vs. allowable length.

4. Attenuation: Report the attenuation value and the frequency at point of failure or the highest frequency passed. Measured attenuation values lower than 3dB used for a pass/fail determination. Report the attenuation per unit length for links longer than 15 meters. Attenuation shall be measured from 1 MHz to 16 Mhz (Category 3) or 100 Mhz (Category 5) in 1 MHz steps.

5. NEXT: Report the NEXT value and “pass or fail” for samples based on the following

Frequency Range (MHz)	Maximum Step Size
(MHz) 1-31.35	0.15
>31.25-100	0.25

6. Submit copies in binder format and 4 copies on compact disks containing all summary reports, full plot data test results, tester software tools required to view and inspect and print any selection of the test reports, spreadsheets, end to end reports and as built drawings called for at the completion of job.

3.4 OPTICAL FIBER CABLE TESTING

A. All fiber testing shall be performed on all fibers in the completed end to end system.

B. Comply with Tier-two testing as defined in TSB-140. which included loss and length testing with an optical loss test set (OLTS) and also an OTDR trace of the installed cable plant. By incorporating the proposed two-tier testing method, installers have the most complete picture of the fiber installation and network owners have proof of a quality installation

C. Testing shall consist of an end to end power meter test performed per EIA/TIA-455-53A. The system loss measurements shall be provided at 850 and/or 1300 nanometers for multimode fibers and 1310 and/or 1550 nanometers for single mode fibers. These tests also include continuity checking of each fiber.

D. There shall be no splices unless clearly called for.

E. Test all fibers with launch and far end cable of sufficient length for the OTDR to be able to see through all installed connectors.

F. Localized attenuation shall not exceed 0.5 dB at any point.

G. Backbone multimode fiber shall be tested in both directions at both 850nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A method B.

H. Backbone single mode fiber shall be tested in both directions at both 1310nm and 1550.

I. Backbone multimode fiber cabling shall be tested at both 850 nm and 1300 nm (or 1310 and 1550 nm for single-mode) in both directions.

J. Test set-up and performance shall be conducted in accordance with ANSI/EIA/TIA-526-14 Standard, Method B.

K. Where links are combined to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. ONLY BASIC LINK TEST IS REQUIRED. The contractor can optionally install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA/EIA Standard.

L. Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.

M. Backbone Cable

1. Test the cable on the reel for continuity before installing it, to insure no damage was done in shipment from the manufacturer to the job site.

2. After installation and termination, test each segment of the cable plant individually as it is installed, to insure each connector and cable is good.

3. Link attenuation is the only required field test except for the patched runs in the campus backbone system where an OTDR test will be required. Use launch cables at each end and provide print outs showing all connectors. OTDR will also be required to determine bad connections or damage when the link attenuation test fails.

4. Maximum localized attenuation allowed is 2dB.

5. Backbone multimode fiber shall be tested in both directions at both 850nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A method B.

6. Backbone single mode fiber shall be tested in both directions at both 1310nm and 1550 nm in accordance with ANSI/EIA/TIA-526-14A method A.1.

7. Multimode fiber shall conform to the following:

850nm:

Length (meters)	Attenuation (dB)
500	3.5
1000	5.5
1500	7.5
2000	9.0

1300 nm:

Length (meters)	Attenuation (dB)
500	2.2
1000	3.0
1500	3.8
2000	4.5

8. Single Mode Fiber shall conform to the following:

Length (meters)	Attenuation (dB)
500	2.0
1000	2.5
1500	3.0
2000	3.5
2500	4.0
3000	4.5

Outside:

Length (meters)	Attenuation (dB)
500	1.8
1000	2.0
1500	2.2
2000	2.5
2500	2.8
3000	3.0

N. Provide attenuation and cable length test results for all installed cable pairs.

3.5 TEST DOCUMENTATION

A. Test report documentation shall be provided in a three ring binder(s) and CD's within 1 week after the completion of the project. The binder and disks shall be clearly marked on the outside front cover and spine with the words "Test Results", the project name, and the date of completion (month and year).

B. The binder and electronic folder/files shall divided by major heading tabs (or in the case of electronic files, be placed into a folders structure similar to the hardcopy tests of this section).

C. Major heading tabs (folders) shall be divided into Horizontal and Backbone. Each shall be further sectioned by test type and by CER and rack. Additional tabs for summary reports by CER shall also be provided.

3.6 IDENTIFICATION & RECORDS

A. Rooms and Spaces (Includes entrance facilities, communication equipment rooms, communication equipment spaces and work areas)

1. Provide lamicoid type label, with 1" high white lettering on the door to room or on the plywood backboard in the case where the wiring closet is located inside a lab or other room. Mechanically fasten the label to the door or plywood. Verify the background color with the architect.

2. Label outlets as called for on labeling detail on drawings. Label outlets in rooms from left to right around the outside.

3. Provide a laminated building map showing floor plan with cable designations wall mounted in easily accessible location.

4. Provide written records in computer generated, table format for all rooms and spaces with the as-built drawings. The table shall include the following information:

   a. Space Identifier
   b. Space type
   c. Pathways terminating in space
   d. Cables that terminate in space
   e. Room numbers served by the CER
   f. Power panel and circuits serving the space

B. Cables

1. Cables shall be marked at each endpoint and at all intermediate pull or junction boxes. Label cables as called for on drawings.

2. Provide written records in computer generated, table format for all cables, with the as-built drawings. The table shall include the following information:

   a. Cable Identifier
   b. Cable type
   c. No. of strands (optical fiber) or pairs (UTP)
   d. Length
   e. Pathway identifiers that cable is routed through
   f. Room number of Station outlet

C. Station Outlets

1. Provide 606 insert with clear plastic label cover on faceplates.

2. Provide a laser printed label in the insert.

3. Provide laser printed adhesive labels on station outlets in surface metal raceway.

4. Label shall have the following identifier scheme AA01

   "A" – Rack , "A" – Patch Panel, 01- Port on patch panel

5. Write the cable identifier of each cable in permanent marker on the inside of each faceplate.

D. Patch Panels

1. Label patch panels with laser printed adhesive markers.
2. Each panel shall be labeled using a Letter designation Access Point A, B etc.
3. Each patch panel port shall be identified with room number that access point is located in.

3.7 END-TO-END REPORTS

A. Provide computer generated spread sheet (Lotus, Excel or Quattro Pro) that details each communication outlet from work area connection to patch panel. The spread sheet shall have columns identifying the station outlet and cable ID room number, pathway ID(s), cable type, and length.

3.8 AS-BUILT DRAWINGS

A. Provide as-built drawings showing all pathways, Station outlets, equipment rooms and entrance facilities on 1/8 scale floor plans.

END OF SECTION 27 16 00

SECTION 27 52 24 - NURSE CALL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes audiovisual equipment using voice communications and microprocessor control. All stations in an area are connected to a master station. Master stations are capable of communicating selectively with each other and with connected patient and other stations.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Detail the system including the following:

1. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.

2. Wiring Diagrams: Power, signal, and control wiring.

3. Station Installation Details: For built-in equipment; dimensioned and to scale.

4. Equipment Cabinet Drawings: Dimensioned and to scale.

C. Coordination Drawings: Detail system components that fit, match, and line up with provisions made in equipment specified in other Sections or in separate contracts:

1. Patient head-wall units.
2. Patient consoles.
3. Patient beds with built-in nurse call features.

D. Manufacturer Certificates: Signed by manufacturers certifying that nurse call equipment complies with requirements.

E. Field Tests Reports and Observations: Include record of final adjustments certified by Installer.

F. Operation and Maintenance Data: For nurse call equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 “CloseOut Procedures," include the following:

1. Operating instructions.

2. Troubleshooting guide.
3. Wiring diagrams and terminal identification.
4. Equipment parts list.
5. Product data for types and sizes of wires and cables used.

G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing equipment similar to that indicated for this Project and that maintains technical support services capable of providing user with training, parts, and emergency maintenance and repair with a 24-hour-maximum response time.

C. Source Limitations: Obtain nurse call equipment components through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

A. Coordinate patient control units with items controlled that are not part of nurse call equipment.

1. TV: Channel selection and volume.
2. Lights: Ambient and reading lights at patient location.

B. Coordinate wiring paths and maintenance access at locations listed below. Coordinate trim features and finishes at these locations to present a unified design appearance.

1. Patient head-wall units.
2. Patient consoles.
3. Patient beds with built-in nurse call features.
4. Nurse station.
5. Boom locations in lab areas.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fails in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:

a. Nickel-Cadmium, Wet-Cell Batteries:

1) Full Warranty: Five years.
2) Pro Rata: 15 years.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: For corridor dome lights and zone lights equal to 20 percent of amount installed.

2. Fuses: One for every 10 of each type and rating, but no fewer than five of each.

3. Printed Circuit Boards: Each kind, equal to 10 percent of amount installed, but no fewer than one unit.

4. Master Station Privacy Handset: One.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Rauland-Borg Corporation – Responder V

2.2 SYSTEM REQUIREMENTS

A. Coordinate the features of materials and equipment to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Expansion Capability: Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and cable conductor quantities adequate to increase the number of stations in the future by 25 percent above those indicated without adding internal or external components or main trunk cable conductors.

C. System shall be tied to existing annunciators for code blue alarms.

D. Resistance to Electrostatic Discharge: System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to electrostatic discharges of up to 25,000 V in an environment with a relative humidity of 20 percent or less.

E. Equipment: Solid state, modular.

F. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.

2.3 FUNCTIONAL PERFORMANCE

A. Station Selection: Master station is capable of selectively communicating with other stations or groups of stations on its system by operating selector switches.

B. Master Station Privacy: Capable of conversing with individual stations in complete privacy.

C. Hands Free: Called station is capable of conversing hands free.

D. Annunciation: At the master station, a tone announces an incoming call and an annunciator light or liquid-crystal display identifies the calling station and indicates the priority of the call. Memory lamps or lighted displays identify stations selected for outgoing calls.

E. System Reset at Master Station: A normal incoming call is canceled, associated lights and audible tones are extinguished, and the system is reset when the station switch is returned to the normal position after responding to a call.

F. Patient Station Call: Lights the call-placed lamp at patient station, zone, and corridor dome lights. It sounds a tone and lights the call lights at staff/duty stations and actuates annunciation at the master station. When the calling station is selected at the master station, the patient can converse with the master station without moving and without raising or directing the voice. During voice communications, entertainment audio at the calling station is automatically muted.

G. Pull-Cord Call Station and Emergency-Call Station Call: Lights call-placed lamp and corridor dome light, and flashes zone light. Master station tone pulses and annunciator light for that room flashes. When master station acknowledges the call by operating a switch, the tone stops but lights continue to flash until the call is canceled at the point of origin.

H. Code Blue, Staff, and Duty Station Call: Lights the call-placed lamp at the station and actuates annunciation at the master station. When the called station is selected at the master station, the caller and the master station operator can converse.

1. Code Blue: Unique sound and light pattern, indicating the highest priority emergency.
2. Staff Station: Unique sound and light pattern, indicating an emergency.
3. Duty Station: Sound and light pattern, indicating a call to the nurse station.

I. Handset Operation: Lifting handset on master station disconnects speaker microphone and transfers conversation to the handset.

J. Station Privacy: No patient, staff, or duty station can be remotely monitored without the lighting of a warning lamp at the monitored station.

K. Patient Station Cord Set: When a patient station cord-set plug is removed from the jack in the station faceplate, a patient station call is initiated as described above. When the master station call button for the station is pressed, the tone stops but lights continue to flash until the call is canceled at the point of origin or the plug is reinserted or replaced with a dummy plug.

L. Patient Control Unit: Controls entertainment volume and channel selection. Speaker is used for both nurse communication and entertainment sound. Entertainment sound is automatically muted when station is communicating with master station. Nurse button on the unit initiates a patient station call.

M. Selective Paging: Master station is capable of initiating a message to selected groups of stations or speakers simultaneously by using station group switches.

N. Staff Reminder: Master station can initiate a staff reminder that a patient requires direct staff response by operating a reminder control while in contact with the patient station. This will light a distinctive-color lamp in the corridor dome light at the patient's room and in the appropriate zone lights. Reminder calls are canceled by operating a staff reminder cancel switch in the patient's room.

O. Call Priority Indication: Call priority switch near each patient station, or integral with the master station, controls the priority status of the call transmitted by individual stations. The switch selects one of the following status levels:

1. Normal: No change to the normal call initiation and canceling sequence.

2. Emergency: Call initiation produces signals and indications identical to those of emergency-call stations. Indicator lamps are extinguished and the system is reset only at the originating station.

3. Priority: System response is the same for emergency status, except voice communication between the master station and the calling station is locked in from the time of call initiation until the system is reset at the originating station.

2.4 EQUIPMENT DESCRIPTIONS

A. Master Station: Speaker-microphone unit with operating controls.

1. Indicator lamps with legends or by liquid-crystal displays designate identification and priority of calling stations and called stations.

a. Pulse rate of incoming-call lights denotes priority of calls awaiting response.

2. Station Selection Controls: Switches select stations for two-way voice communications.

3. Signal Tones: Announce incoming calls.

a. Pulse rate and frequency of tone identify the highest priority call awaiting response at one time.

4. Volume Control: Regulates incoming-call volume.

5. Privacy Handset with Hook Switch: Of the type that does not require push-to-talk switch, attached to each station, unless otherwise indicated.

6. Staff Reminder Control: Initiates flashing of corresponding corridor dome lights for patients requiring service. Permits scanning equipment to indicate which patients are currently in reminder status.

7. Call Priority Selection: Controls associated with patient station selection switches determine the priority indication displayed when a call is initiated at a patient station.

B. Central Equipment Cabinet: Lockable metal. Houses amplifiers, tone generators, power supplies, controls, terminal strips, and other components.

1. Amplifier: With fidelity and overall gain necessary to achieve the sound transmission and reproduction characteristics specified, considering interoperability with the installed speakers/microphones and wiring.

a. Power Output: Not less than 3 W at a total harmonic distortion not exceeding 5 percent.

b. Hum and Noise: 60 dB below full output with normal input open.

c. Volume Control: Concealed within the amplifier unit to control the volume of sound reproduced at all stations.

d. Protection: Circuit to prevent damage to the amplifier in case shorted or open output.

2. Selective Paging Amplifiers: Plug-in card mounted in central equipment cabinet; rated 15 W.

3. System Power Supply: For 24-V dc for operation of the call system.

a. Equipment Rating: Suitable for continuous operation between 32 and 120 deg F (0 and 49 deg C), from a primary line voltage between 105- to 125-V ac, 60 Hz.

b. Output: Regulated 24-V dc with protection against overloads. Line-to-load regulation shall not exceed 2-1/2 percent with ripple and noise remaining below the 10 mV, RMS level.

c. Overload Protection: Electronic fold-back circuit set to limit the volt-ampere output to less than 100 VA during overloaded or shorted output. Restore power output automatically on removal of overload without resetting circuit breakers or replacing fuses.

4. Power-on indicator lamp.

5. Surge Protective Device: Comply with Division 16 Section "Transient Voltage Suppression" for auxiliary panel suppressors, with LED indicator lights for power and protection status.

6. Battery Backup Unit: Sealed nickel-cadmium battery supplies power through an automatic switch when normal power fails, for a period of not less than six minutes at rated output.

    a. Automatic retransfer to normal power, after a15 minute time delay.
    b. Two-rate battery charger with an automatic trickle rate and a recharge rate.

C. Speaker/Microphones:

1. Type: Permanent-magnet, dynamic or ceramic, protected against dust and humidity.

2. Sound Reproduction: Sound level of 90 dB plus or minus 3 dB at a distance of 48 inches on the axis without overdriving or distorting any frequencies between 300 and 3000 Hz when installed in an enclosure or in the pillow speaker.

3. Power Handling Capacity: Not susceptible to damage from overdriving within the range of power available from the amplifier.

4. Impedance Matching: Coordinated and matched to the input and output circuits of the amplifier, both for single connection and for group monitoring, to provide the sound reproduction specified. Subsystems or components shall not be combined, which could cause unacceptable distortion such as feedback between pillow speakers and unmuted room speaker/microphone combinations. This protection shall extend throughout the entire range of operation (volume control) of all components.

D. Single-Patient Station: Combination of speaker microphone with 2-inch dynamic cone, a polarized receptacle to match the cord-set plug, monitor lamp, reset switch, and call-placed lamp; with a staff station and code blue station in one unit.

E. Staff and Duty Stations: Audible call-tone signal device, speaker microphone with 2-inch dynamic cone, monitor lamp, reset switch, routine-call lamp, emergency-call lamp, and call push button; assembled under a single faceplate.

F. Code Blue Station: Audible call-tone signal device, speaker microphone with 2-inch dynamic cone, monitor lamp, reset switch, Code Blue emergency-call lamp, and call push button; assembled under a single faceplate.

G. Call Priority Switch Station: Three-position, tamper-resistant priority selection switch. Positions designated by labeling "Normal," "Emergency," and "Priority."

H. Staff Reminder Cancel Switch Station: Momentary contact.

2.5 MISCELLANEOUS EQUIPMENT COMPONENT DESCRIPTIONS

A. Pull-Cord Call Station: Water-resistant construction to be provided in all shower applications. Includes the following, mounted under a single faceplate:

1. Pull-Down Switch: Lever-locking type, labeled "Pull Down to Call Help."
2. Reset trigger.
3. Call-placed lamp.

B. Patient Control Unit: Equipped with plug and 96-inch long white cord.

1. Ethylene oxide, sterilizable.

2. Light-Control Switch: Arranged for independent on-off control of patient's up and down light.

3. Integral Speaker: 2 inches with 0.35-oz. (9.9-g) magnet, rated 0.2 W.

4. Controls: Speaker volume, TV control, and nurse call.

5. Housing: High-impact white plastic.

6. Attachment: Stainless-steel bed clamp with permanently attached Mylar strap.

7. Quantity: 12 units for every 10 patient beds.

C. Call-Button Cord Set: Plug and 72-inch white cord; equipped with momentary-action, call-button switch.

1. Ethylene oxide, sterilizable.
2. Washable cord.
3. Palladium switch contacts in high-impact white housing with cord-set strain relief.
4. Attachment: Stainless-steel bed clamp with permanently attached Mylar strap.
5. Quantity: 3 cord sets for every 10 patient beds.

D. Geriatric Call-Button Cord Set: Plug and 72-inch white cord; equipped with momentary-action, light-pressure switch in soft outer jacket.

1. Ethylene oxide, sterilizable.
2. Washable cord.
3. Palladium switch contacts in high-impact white housing with cord-set strain relief.
4. Attachment: Stainless-steel bed clamp with permanently attached Mylar strap.
5. Quantity: 2 cord sets for every 10 patient beds.

E. Squeeze-Bulb Switch Cord Set: Plug and 72-inch washable tube with white, washable, neoprene squeeze-bulb activator, plug-mounted, momentary contact switch.

1. Ethylene oxide, sterilizable.
2. Attachment: Stainless-steel bed clamp with permanently attached Mylar strap.
3. Quantity: 2 cord sets for every 10 patient beds.

F. Call-Button Plug: Designed to plug into patient station cord-set receptacle. Button switches call circuit. Furnish 2 plugs for every 10 patient beds.

G. Dummy Plugs: Designed to plug into patient station cord-set receptacle when call-button plug or patient cord set is not used. Furnish 3 plugs for every 10 patient beds.

H. Indicator Lamps: Light-emitting-diode type with 20-year rated life, unless otherwise indicated.

I. Station Faceplates: High-impact plastic color as selected by Architect. Molded or machine-engraved labeling identifies indicator lamps and controls.

J. Corridor Dome Lights and Zone Lights: Three-lamp signal lights.

1. Lamps: Front replaceable without tools, low voltage with rated life of 7500 hours. Barriers are such that only one color is displayed at a time.

2. Lenses: Heat-resistant, shatterproof, translucent polymer that will not deform, discolor, or craze when exposed to hospital cleaning agents.

3. Filters: Two per unit, amber and red.

K. Cable: Features include the following, unless otherwise indicated:

1. Conductors: Jacketed single and multiple twisted-pair, copper cables. Sizes and types as recommended by equipment manufacturer.

2. Cable for Use in Plenums: Listed and labeled for plenum installation.

L. Grounding Components: As specified in Division 26 Section "Grounding."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method: Install wiring in raceway except within consoles, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

B. Wiring Method: Install wiring in raceway except within consoles, desks, and counters; and except in accessible ceiling spaces and in gypsum board partitions, where cable wiring method may be used. Use UL-listed plenum cable in environmental air spaces including plenum ceilings. Conceal cable and raceway wiring except in unfinished spaces.

C. Install cables without damaging conductors, shield, or jacket.

D. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.

E. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously if more than one is being installed in same raceway.

2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.

3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.

F. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.

G. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train conductors to terminal points with no excess. Provide and use lacing bars in cabinets.

H. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide 12-inch minimum separation between conductors to speaker microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.

I. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets, and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.

J. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.

K. Identification of Conductors and Cables: Retain color-coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams. Label stations, controls, and indications using approved consistent nomenclature.

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Label exposed cables at intervals not exceeding 15 feet.

3. Prepare cable administration drawings to show building floor plans with cable administration point labeling. Identify labeling convention and show labels for terminal hardware and positions, cables, stations and devices and equipment grounding conductors.

3.2 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.

C. Grounding Provisions: Comply with requirements in Section 26 05 26 "Grounding and Bonding."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect test and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.

B. Test Procedure: Comply with the following:

1. Schedule tests a minimum of seven days in advance of performance of tests.

2. Report: Submit a written record of test results.

3. Operational Test: Perform an operational system test, and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and all-call messages and pages at each nurse call station. Verify proper routing, volume levels, and freedom from noise and distortion. Test each available message path from each station on the system. Meet the following criteria:

a. Speaker Output: 90 dB plus or minus 3 dB, 300 to 3000 Hz, reference level threshold of audibility 0 dB at 0.02 millipascals of sound pressure.

b. Gain from patient's bedside station to nurse station, with distortion less than 65 dB (plus or minus 3 dB, 300 to 3000 Hz).

c. Signal-to-Noise Ratio: Hum and noise level at least 45 dB below full output.

4. Test Procedure:

a. Frequency Response: Determine frequency response of two transmission paths by transmitting and recording audio tones.

b. Signal-to-Noise Ratio: Measure the ratio of signal to noise of the complete system at normal gain settings, using the following procedure: Disconnect a speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise and repeat the test for four speaker microphones.

c. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 300, 400, 1000, and 3000 Hz into each nurse call equipment amplifier, and measure the distortion in the amplifier output.

C. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets these Specifications and complies with applicable standards. Report results in writing.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sound levels and controls to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal operating hours for this purpose.

3.5 DEMONSTRATION

3.6 Engage a factory-authorized service representative to train Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse call equipment. Refer to Division 01 Section "Closeout Procedures."

END OF SECTION 27 52 24

SECTION 28 31 02 - MULTIPLEX FIRE ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes fire alarm systems. The existing system is manufactured by Simplex. New devices, booster, panels, etc. shall match existing devices and be provided as required. This project will be constructed in multiple phases. Contractor shall review phasing with construction manager and include in bid necessary programming, testing, etc. required per phasing of project.

B. Related Sections include the following:

1. Division 08 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.3 DEFINITIONS

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Noncoded, addressable system; multiplexed signal transmission dedicated to fire alarm service only.

1. Interface with existing fire alarm system.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Automatic sprinkler system water flow.
5. Fire extinguishing system operation.
6. Fire standpipe system.

C. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Unlock electric door locks in designated egress paths.
6. Release fire and smoke doors held open by magnetic door holders.
7. Activate voice/alarm communication system.
8. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
9. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
10. Record events in the system memory.
11. Record events by the system printer.
12. Transmit alarm signal to elevator(s)
13. Transmit signal to security system.

D. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper.

E. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.

2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.

3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

F. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event on system printer.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire alarm system design.
b. Fire alarm certified by NICET, minimum Level III.

2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

3. Device Address List: Coordinate with final system programming.

4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.

5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code. Wiring diagrams shall be specific for this project. Manufacturers standard wiring diagrams for generic systems are not acceptable.

6. Batteries: Size calculations.

7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

8. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

9. Voice/Alarm Signaling Service: Equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

10. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 01 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

G. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.

2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.

   a. Hard copies on paper to Owner, Architect, and authorities having jurisdiction.
   b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Work of this Section will be performed by a UL-listed company.

C. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Fire Alarm Service: Do not interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of fire alarm service.

2. Do not proceed with interruption of fire alarm service without Construction Manager's and Owner's written permission.

1.9 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of the new fire alarm system, remove existing disconnected fire alarm equipment.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.

2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.

3. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than one unit of each type.

4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than one unit of each type.

5. Keys and Tools: One extra set for access to locked and tamper-proofed components.

6. Audible and Visual Notification Appliances: One of each type installed.

7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FACP and Equipment: Existing

a. Simplex, Johnson Controls

2. Wire and Cable:

a. Comtran Corporation.
b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
d. West Penn Wire/CDT; a division of Cable Design Technologies.

3. Audible and Visual Signals:

   a. True Alert, Simplex

2.2 EXISTING FIRE ALARM SYSTEM

A. Compatibility with Existing Equipment: Fire alarm system and components shall operate as an extension of an existing system.

2.3 MANUAL FIRE ALARM BOXES – MATCH EXISTING

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.

2. Station Reset: Key- or wrench-operated switch.

3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

4. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.

2.4 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

3. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.

4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

5. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.

6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg F per minute.

b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 135 or 155 deg F.

c. Provide multiple levels of detection sensitivity for each sensor.

B. Ionization Smoke Detector:

1. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.

2. Detector Sensitivity: Between 0.5 and 1.7 percent/foot smoke obscuration when tested according to UL 268A.

C. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.

1. UL 268 listed, operating at 24-V dc, nominal.

2. Pipe Network: Electrical metallic tubing connects control unit with designated sampling holes.

3. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of three preset values.

4. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg (12.5 Pa) at all sampling ports.

5. Control Unit: Single or multizone unit as indicated. Provides same system power supply, supervision, and alarm features as specified for the central FACP plus separate trouble indication for airflow and detector problems.

6. Signals to the Central FACP: Any type of local system trouble is reported to the central FACP as a composite "trouble" signal. Alarms on each system zone are individually reported to the central FACP as separately identified zones.

D. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:

a. Sensor: LED or infrared light source with matching silicon-cell receiver.

b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

c. Air Velocity Rating: 100 to 4000 feet per minute.

d. Warranty: 3 year

e. Powered outputs for removed LED and remote test.

f. Four (4) form "C" auxiliary contacts.

1) (1) set for fire alarm “alarm” signal
2) (1) set for fire alarm “trouble” signal
3) (1) set for ATC panel
4) (1) set for unit shut down

g. Communication line with power compatible 24 VAC/DC or 120/220 VAC.

h. Detector to be an intelligent photoelectric detector specifically designed for use in air handling systems. Detector sensitivity changes caused by dirt, temperature or humidity are compensated by the control panel compensation algorithms to maintain constant sensitivity.

i. Airtight smoke chamber in compliance with U.L.

j. Voltage: 15 to 32 VDV

k. Operating Temperature: 32 F to 131 F.

l. Operating Humidity Range: 10% to 93% relative humidity

2. UL 268A listed, operating at 24-V dc, nominal. U.L. recognized field receptacle power and sensor boards.

3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.

5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where indicated.

7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

8. Each sensor shall have multiple levels of detection sensitivity.

9. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.

10. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.5 HEAT DETECTORS

A. General: UL 521 listed.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or rate-of-rise of temperature that exceeds 15 deg F per minute, unless otherwise indicated.

1. Mounting: Plug-in base, interchangeable with smoke-detector bases for outlet box mounting.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.

1. Mounting: Plug-in base, interchangeable with smoke-detector bases for outlet box mounting.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.6 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated and with screw terminals for system connections.

1. Sound levels shall be field adjustable for high or low.
2. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.

B. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output measured at 10 feet from the chime.

C. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output measured at 10 feet from the chime.

D. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output: 75 candela.
2. Strobe Leads: Factory connected to screw terminals.

E. Voice/Tone Speakers:

1. UL 1480 listed.
2. High-Range Units: Rated 2 to 15 W. – Use in <describe area>.
3. Low-Range Units: Rated 1 to 2 W. – Use in <describe area>.
4. Mounting: Flush, semi-recessed, or surface mounted; bidirectional as indicated.
5. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.

2.7 SPRINKLER SYSTEM REMOTE INDICATORS AND SMOKE DETECTOR REMOTE INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
3. Rating: 24-V ac or dc.
4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

C. Electromagnetic hold – open devices, provided with the door hardware specified elsewhere. Coordinate voltage and power requirements with hardware supplier.

2.9 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall. to a circuit-breaker shunt trip for power shutdown.

2.10 SYSTEM PRINTER

A. Listed and labeled as an integral part of the fire alarm system.

2.11 GUARDS FOR PHYSICAL PROTECTION

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of the device.
2. Finish: Paint of color to match the protected device.

2.12 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.

1. Connect new equipment to the existing control panel in the existing part of the building.
2. Connect new equipment to the existing monitoring equipment at the Supervising Station.
3. Expand, modify, and supplement the existing control and monitoring equipment as necessary to extend the existing control and monitoring functions to the new points. New components shall be capable of merging with the existing configuration without degrading the performance of either system.

B. Smoke or Heat Detector Spacing:

1. Smooth ceiling spacing shall not exceed 30 feet.

2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.

3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

C. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct. Duct type smoke detectors shall be provided and wired by the electrical Contractor. Installation shall be by the Mechanical Contractor.

E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

G. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

J. Mounting heights for all devices shall comply with ADA.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:

1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a metal raceway system in walls or non-accessible ceiling spaces or where subject to harm. Plenum rated cables may be used above accessible ceiling spaces and in open joist spaces.

C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.

2. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI is permitted only where indicated on the drawings.

3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as fire alarm signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Section 26 05 53 "Identification for Electrical Systems."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 SUPPLEMENTAL EQUIPMENT AND OPERATIONAL REQUIREMENTS

A. Run all fire alarm initiating and indicating device wiring, including multiple (3) addressable wiring loops to the fire alarm control panel. Make all final wiring terminations and supply all ancillary equipment in order to provide a complete and operable system.

B. Provide all required auxiliary contacts and all wiring to the elevator controller for fireman's and emergency return service. < Provide auxiliary contacts at elevator shaft smoke detectors and interface wiring to the elevator roof smoke vent. Make all final connections to smoke vent. > In the event of a power outage, elevator shall be recalled to a safe floor and doors commanded to open position.

C. Upon activation of a manual fire alarm station, the following actions shall occur:

1. Sound an audible alarm throughout the facility.

2. Activate the strobe lights throughout the facility

3. Indicate the point in alarm at the command center display and at the annunciators. Print the point in alarm at the command center.

4. Activate municipal trip for "manual station".

5. Release all electric door locks at secured doors through an interface with the security system equipment.

6. Communicate a signal to ATC. Fan shut-down shall occur through the detectors which protect the respective air handling unit or smoke dampers.

D. Upon activation of an area smoke detector, area heat detector, duct detector or sub-system alarm contact, the following actions shall occur:

1. Initiate a 30 sec. alarm verification timer for the device.

2. Sound an audible alarm throughout the facility.

3. Activate the strobe lights throughout the facility.

4. Indicate the point in alarm at the command center and annunciator panel(s). Display and print the point in alarm command center.

5. Activate municipal trip for "automatic device".

6. Duct type smoke detectors at air handling units shall be used to shutdown the units. The Division 23 Contractor shall wire through auxiliary contacts in the detector base for this purpose. At smoke dampers, the Division 26 Contractor shall wire through the auxiliary contacts in the detector base to the damper motor where the motor is 120 volts. Where the damper motor is low voltage, the wiring shall be by the Division 26 Contractor.

7. Release all electric door locks at secured doors through an interface with the door hardware or access control equipment.

8. Shutdown of air handlers shall be accomplished directly through detector auxiliary contacts, <u>not</u> via the building management system.

E. Upon activation of a sprinkler waterflow switch the following shall occur:

1. Sound an audible alarm throughout the facility.

2. Activate the strobe lights throughout the facility.

3. Indicate the point in alarm at the command center and annunciator panel(s). Display and print the point in alarm at the command center.

4. Activate municipal trip for "waterflow".

5. Release all electric door locks at secured doors through an interface with the door hardware or access control equipment.

F. Upon activation of a sprinkler tamper switch or sub-system supervisory alarm the following shall occur:

1. Indicate the supervisory point at the command center.
2. Activate municipal trip for "supervisory condition".

G. Upon activation of a "master alarm" switch at the fire command station, the following shall occur:

1. Sound an audible alarm throughout the facility.
2. Activate the strobe lights throughout the facility.
3. Release all electric door locks at secured doors through an interface with the security system equipment.

H. Provide fault isolation modules after every 20 devices on all addressable wiring loops. Provide end of line resistors, end of line relays, monitor and control modules, and fan shutdown contacts, based on quantities of devices indicated or required.

I. Provide signal expander panels and all ancillary equipment required where horn and strobe circuits exceed manufacturer recommended distance limitations. Coordinate locations with engineer during equipment submittal phase of project.

J. Provide all ancillary equipment at fire alarm panel for interface with security door release system and the ATC system. Division 26 Contractor is solely responsible for coordinating all wiring, voltage requirements, etc. required to provide a complete operable system.

K. Relays or contacts in starters, required for shut-down functions of air handlers or smoke dampers shall be provided by the Division 23 Contractor.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

D. Perform the following field tests and inspections and prepare test reports:

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.

2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.

    a. Include the existing system in tests and inspections.

3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.

4. Testing: Follow procedure and record results complying with requirements in NFPA 72.

    a. Detectors that are outside their marked sensitivity range shall be replaced.

5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

C. Semiannual Test and Inspection: Six months after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

D. Annual Test and Inspection: One year after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 01 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 28 31 02

SECTION 28 34 00 - ACCESS CONTROL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment, engineering and service necessary to provide a complete and operating access control system as shown on the drawings and described herein.

B. The complete system will include the following components:

1. Access control power supplies, I/Os, processors and remote interfaces
2. Interface to existing access control server
3. Stock of 500 keyfobs or cards as selected by Owner
4. Proximity readers
5. KeyPads
6. Door contacts and request to exit devices

C. The Contractor shall contract with owner’s vendor to furnish all equipment, program the system and tie into existing access control server.

PART 2 - PRODUCTS

2.1 PROXIMITY READERS

A. Standard proximity readers: Reader shall be mounted on a single gang switch box. A selectable jumper shall be available for improved performance when mounting directly to metal.

B. The reader shall contain an LED and a beeper that can be controlled individually by the host system.

C. On reader power-up, an internal self-test routine shall check and verify the setup configuration, determine the internal or external control of the LED and beeper, and initialize the reader operation.

D. The reader shall be sealed in a weatherized polycarbonate enclosure designed to withstand harsh environments and provide a degree of vandal resistance for reliable performance anywhere.

E. The reader shall interface with all existing Wiegand protocol access control systems. Reader output shall be in Wiegand format, or optional RS232 or RS422 serial interface.

F. The reader shall include a tamper switch to provide electronic notification of reader tampering.

G. The reader shall be provided with, an integrated, weatherized keypad. The reader keypad interface with the host system shall be either by sending the keypad data over the data output lines or via a direct connection to the host keypad interface.

2.2 ACCESS CONTROL KEYPAD

A. 500 users

B. Single gang flush mount design

C. Metal braille alpha-numeric keys

D. Brushed metal trim

E. Conformal coating

F. Key press feedback via sounder and yellow LED

G. Built-in assignable sounder

H. Bi-color Red/Green LED indicates relay status

I. Indoor/outdoor use

J. Keypad programmable

K. Five-year warranty

L. Design Make: Linear 2000eM

2.3 REQUEST TO EXIT MOTION SENSORS

A. Wall mounted area motion sensor:

1. 30’ x 35’ viewing pattern.
2. Suitable for wall mounting. Provide swivel mounting bracket as required
3. Dual passive infrared and microwave motion sensing technology.
4. Two user adjustable PIR sensitivity adjustments.
5. One “Form C” contact.
6. One tamper output contact.

2.4 DOOR CONTACTS

A. Button type magnetic contact:

1. 1” diameter magnetic door contacts. Magnet installs in door, contact installs in door frame.

2. Provide single pole, double throw contact with 1’ long #22 AWG leads brought out.

3. Maximum ½” gap.

4. Provide contact that will not affect the fire integrity of U.L. listed fire rated doors.

B. Surface mount magnetic contact:

1. Nominal 2” long x ½” wide x ½” deep.

2. Magnet installs surface mounted on door. Contact installs surface mounted on door frame.

3. Provide single pole, double throw contact with 1’ long, #22 AWG leads brought out.

4. Maximum 1” gap.

PART 3 - EXECUTION

3.1 SYSTEM PROGRAMMING

A. The system installer shall meet with the owner as many times as necessary to finalize system programming. The installer shall review the owner’s security plans and policies and make programming decisions based on that plan.

B. The system installer shall provide a word document that describes the complete operation of the system as decided on during the programming meeting(s). The owner will sign off on the sequence of operation prior to the system programming commencing.

C. The installer shall make changes to the initial system programming for up to 120 days after the initial installation at no additional cost.

3.2 GENERAL INSTALLATION

A. Installation of the system shall include the appropriate equipment and shall be performed by a factory-trained Installer. The installation shall be completed to meet the requirements of this specification and the project drawings. The installation shall include the following:

1. Site planning and system configuration of field hardware

2. Complete hardware setup of all system Workstations, servers and peripherals.

3. Complete configuration of all system Workstations, peripherals and installation of field hardware.

4. Setup of specific network software and hardware configuration requirements.

5. Badge Design and Screen Format installation and verification.

6. Complete system diagnostics verification.

7. Complete system operation verification.

8. Problem reporting and tracking.

9. Project specific installation log.

10. Completion of specific customer acceptance test plans.

11. Formal turnover of the specific project installation documentation to the owner and his Maintenance Service Organization.

B. Coordinate installation of Access control hardware with electric locks

C. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

D. The Contractor is responsible to remedy defects due to faulty workmanship and materials that appear within one year from the date of acceptance in accordance with the General Conditions, unless Specifications specify a different duration.

E. There is a proposed main security room layout shown on the plans. The contractor and engineer will determine the final layout after the equipment is approved. Submit a proposed layout of with equipment submittals. Show all equipment, devices and furniture in plan and elevation views. Show elevations of all for walls.

3.3 SYSTEM ACCEPTANCE TEST

A. Phased Testing: A phased acceptance test and performance demonstration program shall be developed and documented by the Contractor. These requirements shall apply to all system components and software, including, but not limited to all system computers, field panels, proximity reader devices, Photo Imaging system peripherals, CCTV cameras and equipment and interface capability. The Contractor shall perform the tests and document the results under the supervision and witnessing of the SMS Systems Engineer. Operational scenarios shall be developed and used by the Contractor to simulate the actual use of the system in the normal environment of the Owner's facility. The Owner reserves the right to modify the Contractor's plan or develop new operational test and evaluation procedures to effectively document system operations.

3.4 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, data sets and the hardware and peripherals. All updates, addendum and adjustments to the documentation shall be provided at no additional charge, in the same quantities as originally required.

B. System Administrator Manual - Overview and step by step guide and instructions detailing all System Administrator functions.

C. User Manual - Step by step guide and instructions detailing all system user functions and responsibilities.

D. Photo Imaging User's Manual - Step by step guide and instructions detailing all image capture, badge creation, cardholder modification and all Photo Imaging user functions and responsibilities

E. Technical Maintenance Manual - Shall be a comprehensive and detailed document providing all maintenance action, system testing schedules, troubleshooting flowcharts, functional system layout and block diagrams and schematic diagrams of all system wiring.

3.5 MAGNETIC DOOR CONTACTS

A. Install magnetic contacts in locations shown on plans.

B. Provide conduit or surface metal raceway from the accessible ceiling space to the door contact. Install conduit concealed wherever possible.

C. Coordinate work with general contractor

D. Provide button type where possible or surface type where required.

3.6 DOOR HARDWARE

A. Coordinate installation with door hardware furnished by general contractor.

3.7 WARRANTY

A. Provide two-year warranty

END OF SECTION 28 34 00